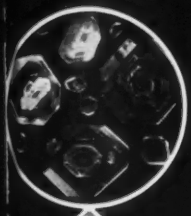
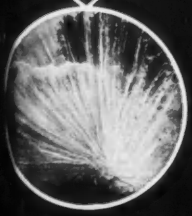
CHEMISTRY

DURHAM, N. C.





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Editorial:
Revolution Within the Atom
Inside Front Cover

50¢

Revolution Within The Atom

➤ FROM THE STANDPOINT of running an automobile or even building some of the most precise of mechanisms, the discoveries of the 20th century with regard to the modifications of so-called classical mechanics and subatomic physics are not practically important in the sense of the engineer who deals with more or less everyday things.

Einstein did create a revolution. But the machineshop and factory are not directly affected by it in the conventional sense. True, the whole atomic energy program, which affects everyone, is due in large measure to him.

And relatively is beginning to affect the way we think about the universe and that has its impact upon our philosophies and even our religions. Less than four decades have passed since the beginning of relativity and less than half that time since the atomic fulfillment of Einstein's mass-energy relationship.

In chemistry and physics, particularly, the only constant thing is change. Witness the ferment concerned with the many kinds of so-called fundamental particles and the many theories and experiments that concern them and the part of the universe within the atom.

The latest development in this progress is reported in the first article of this issue. The future will bring other such revolutions for our mental and material existence. Most of them will not concern most people when they hear about them, if they do. But from them may come the equivalent of another atomic age.

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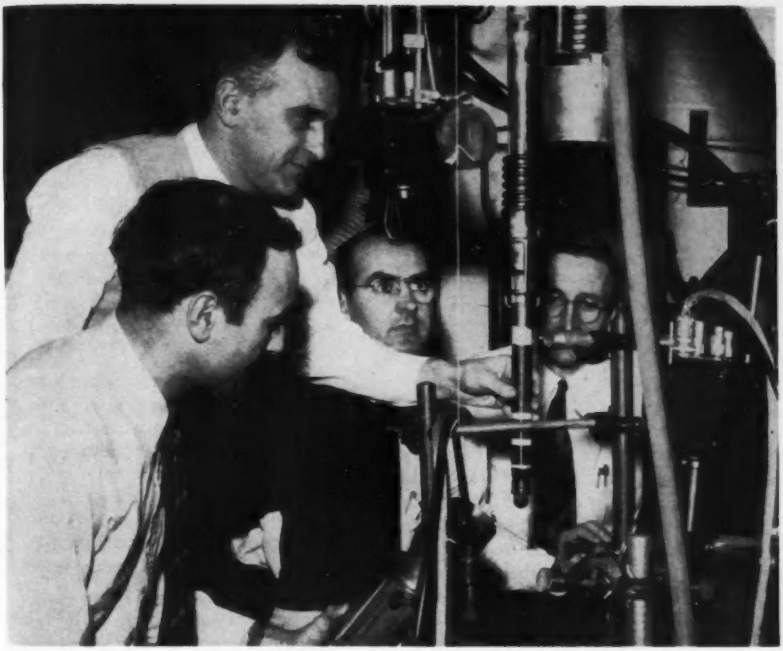


➤ LOW-TEMPERATURE *equipment used in the National Bureau of Standards experiments that helped to disprove the principle of "conservation of parity." The scientists are D. Ralph P. Hudson, Dr. Ernest Ambler, Mr. D. D. Hoppes, and Dr. R. W. Hayward.*

New Sub-Atomic Laws

➤ THE WHOLE body of theoretical physics as it relates to building blocks within the atom's core has been "cracked wide open" in the same way that Einstein with his theory of relativity remade the physical world about the time of World War I.

The laws of matter governing the action of elementary particles that make up all of the universe have proved different from those scientists for three decades or more have assumed.

Two sets of experiments reported relate to the way in which the little known meson particles disintegrate.

In one case, a Chinese woman physicist, associate professor Chien Shiung Wu, born in Shanghai, together with a group of National Bureau of Standards scientists, Drs. E. Ambler, R. Hayward, D. D. Hoppes, and R. D. Hudson, studied the beta decay

of oriented nuclei. In another case, a group from Columbia University, Dr. Richard L. Garwin, Prof. Leon M. Lederman and Marcel Weinrich, studied the angular assymetry in electron decay of mu mesons.

Both of these experiments were suggested by two theoretical physicists, both Chinese born, Dr. T. D. Lee of Columbia and Dr. C. N. Yang of the Institute for Advanced Study, Princeton.

They wanted an answer to whether what physicists call parity is conserved, as it has to be under the older formulations now revised. In effect, both experiments, conducted in one case at subfrigid temperatures at the National Bureau of Standards and in the other case with Columbia's Nevis cyclotron, demonstrated that the conservation of parity or the "invariance of spatial inversion" is not correct.

This can be explained by imagining that, if spinning particles existed in this world and were compared with particles in another world, it would be possible by the sense of rotation to determine whether they are right-handed or left-handed in their spin. This would not be possible under the older parity idea.

The experiments also destroy the principle of what is called "charge conjugation invariance."

The experiments are continuing in the expectation that they will throw some light upon the matter of the reversal of time, that is, if events were run backward like a movie projector, could the difference be told. The scientists emphasized that now the door is open to a new foundation for elementary particle physics.

One scientist said that heretofore physicists have been knocking with their heads against a door painted on the wall and now they know that some real door does exist.

The old theories which have worked in connection with modern physics, just as classical mechanics worked in practical things before Einstein's relativity, are known to be inaccurate by one part in ten to the 25th power, or one part in 10 followed by 25 zero's.

An effect of this size could not be discovered in strong interactions between particles and only showed up in the very-weak effect of the unusual particles used.

Concept of Parity

The experiments showed that parity is not conserved in weak interactions.

The concept of parity, although actually significant only in the realm of microscopic (atoms and particles) physics, has a well defined every-day definition. One way of describing this is as follows:

Suppose we are in communication with an intelligent civilization on another world and wish to determine whether their clocks run in the same sense as ours do, or again whether they mean the same thing by left-handed and right-handed as we do. We have always believed that communication of this idea, in the spirit of this analogy, is impossible. There was no absolute, universal sense to "handedness." However, the stranger's laws of physics are perfectly good — even if his definition is opposite to ours for, say, a left hand screw and a right hand screw.

➤ THESE TWO *theoretical physicists, Dr. T. D. Lee of Columbia University and Dr. C. N. Yang of the Institute for Advanced Study, proposed the experiments that open the way to a correct and unifying theory of elementary particles.*

The statement that the two worlds, one based upon a left handed system and one based upon a right handed system, have the same laws in physics is known as an "Invariance principle," i.e., the laws of physics are said to be invariant or unchanged, if the right hand and the left hand convention are interchanged. The interchange is a reflection in the sense that a mirror image is a reflection in the plane of a mirror. Physicists refer to this reflection as a "parity operation." The Principle of Invariance to Reflection or to Parity Operation has been built into physical theories since 1925 and serves as a severe restriction on the types of laws predicted by these theories. It is this principle which has been destroyed by the recent Columbia experiments.

The main reason for this is that it has been discovered that elementary particles — neutrinos and mesons — possess a "handedness" as an intrinsic property. One must now speak of a left or right handed neutrino, for example. More precisely, these particles must now be considered to possess, in addition to charge, mass, spin, etc., properties analogous to a screw. That is, they have a favored rotation or spin, and an advance along the axis of rotation, either in the right-handed or the left-handed manner. Another way of describing the situation is to compare an elementary (spinning) particle with a spinning bullet. If the shape of the bullet were a perfect cylinder, there would be no screw defined, or no handedness, since the two ends of the bullet are identical.

The new concept of particles is now in analogy with a normal bullet (pointed nose) which differentiates one end of the spin from the other. Particles which "point" in one di-

rection relative to the sense of rotation are called right-handed, etc. The fact that such particles exist on this world and on the other world now permits an absolute identification of right and left hand between the two worlds, in violent disagreement with previous concepts. No theory which has included the parity idea would have been successful.

These experiments, proposed by Drs. Lee and Yang, now at last open the way to a correct and unifying theory of elementary particles. Drs. Lee and Yang also point out that the overall symmetry of the universe may still be preserved by assuming that, if our galaxy is essentially right-handed, some distant galaxy may be in turn left-handed. It may be that this assumed distant galaxy is identical to the hypothetical anti-matter, now a subject of intense speculation. This would represent an enormous simplification in our theoretical attack on the structure of the universe.

Explaining K-Mesons

The proposal that the parity law may not be true, made by Drs. Lee and Yang last summer, was an attempt to reconcile data obtained with the super-atom smashers, the Brookhaven Cosmotron and the Berkeley Bevatron. The data consisted of the study of the properties of the unstable K-mesons, particles which were only recently discovered (1952-53). One aspect of K-meson disintegration seemed to violate the parity law. So deeply rooted was this law, that the entire world of physics was completely baffled by the K-meson puzzle, the general feeling being that the K-mesons, being newly discovered, were just not well enough understood. Drs. Lee and Yang boldly made the break and re-examined the consequences of removing the parity law for radioactive disintegrations of nuclei and particles. They found, to their surprise, that none of the existing data would be in contradiction and that certain crucial experiments, dealing with more well known particles, could give decisive answers.

Oriented Nuclei

To detect the "handedness" of particles, the radioactive nucleus cobalt 60 was cooled to a temperature of 0.01 degree above absolute zero. At this temperature, all thermal motions are reduced to extremely small values. The application of a magnetic field will cause most of the cobalt nuclei, which are known to be spinning, to align themselves, like small magnets, parallel to the applied magnetic field. The radioactive cobalt nuclei disintegrate, giving off electrons. The crucial point is the comparison of the number of electrons emitted along the direction of spin to the number going in the opposite direction. The very fact that these numbers are different, indicates the favoring of a direction associated with the spin, that is, a "handedness" in the sense of a screw. Moreover, the magnitude of the difference was sufficiently large to indicate a violation of charge conjugation invariance.

The technical aspects were quite difficult. At the request of and in collaboration with Prof. Wu, the National Bureau of Standards low temperature physics group undertook experiments to verify the theoretical considerations. This group assisted by National Bureau of Standards specialists in radioactive meas-

urements, provided the techniques and experience for completing the project successfully. Scintillation counters had to be installed within the complex vacuum and cooling system and extreme care had to be taken to eliminate spurious effects.

Meson Decays

In this experiment, two parity violations were detected, as well as the violation of charge conjugation invariance. It was discovered that when the familiar pi meson (well known since 1947 and known to be principally responsible for the *force* that holds nuclei together) disintegrates into a mu meson and a neutrino, the mu meson always spins in the direction of its motion. Here again, the mu advances as if it were a screw and demonstrates the parity-violation "handedness." The alignment of mu spins was detected by counting the end products of the radioactive mu meson decay, again electrons, which were found to favor one direction of spin of the parent mu meson over the other, in their direction of emis-

➤ ABOVE. *Columbia University scientists, Dr. R. L. Garvin and Prof. L. M. Lederman, studied the angular asymmetry in electron decay of mu mesons.*

➤ BELOW. *Associate Professor Chien Shiung Wu of Columbia University worked with National Bureau of Standards scientists to measure the beta decay of oriented nuclei.*

sion. As a by-product of this experiment, the strength of the small "magnet" carried by the mu meson, called a magnetic moment, was measured to a precision of 5%. Magnetic moments of electrons are known to precisions of 0.005% (by Dr. P. Kusch, who won a Nobel prize) but the number of particles available is 10^{20} whereas in this experiment, less than 50,000 particles were counted. Oriented mu mesons are extremely sensitive to weak magnetic fields and this technique will prove a powerful tool in probing the magnetic fields inside nuclei and atoms and between atoms.

The latter experiment was carried out at Columbia's Nevis Cyclotron Laboratories, in Irvington-on-Hudson, New York.

Thyroid Gland Hot Spots

➤ SOME CASES of psychological or mental illness might be due to "hot" spots in the thyroid gland in the neck. This possibility is being explored by scientists at the Menninger Foundation, Topeka, Kansas.

Patients with overactive thyroid glands usually have a cluster of "psychoneurotic" complaints such as sleeplessness, irritability, restlessness, unexplainable crying spells, apprehensiveness and nightmarish dreams.

The Menninger scientists gave a group of patients with these symptoms tracer doses of radioactive iodine. Iodine is used by the thyroid gland to manufacture its hormone. The tracer doses showed that the glands of this group of patients had overall normal functioning, but had small, localized spots of overactivity. These spots were called "hot nodules" because they picked up the radioactive chemical in excess amounts.

Now the scientists are trying to learn whether patients with such "hot" spots in their thyroids have a common personality makeup and whether treating the thyroid will overcome the "psychoneurotic" symptoms.

Scientists working on this research are Drs. Robert S. Wallerstein, Philip Holzman, Nathaniel Uhr, Homer Hiebert, Frank Hoecker and H. W. Barrett and Mr. Richard Siegal.

On the Back Cover

➤ SYNTHETIC RUBBER *production set new records in 1956 in plants like this one of The Firestone Tire & Rubber Company, which in recent years have sprung up and expanded from the Gulf Coast to the northern boundaries of Ohio. More than 60% of the rubber made into finished products in 1956 was synthetic. Total production this year will be well over 1,000,000 tons.*

Chemical Basis of Living Matter Investigated

RNA Synthesized in Laboratory

➤ WORK BY an international group of scientists has led to the laboratory synthesis of RNA (ribonucleic acid), the energy-packed cell machinery that manufactures protein. RNA is also found in the genes of cells in another form (DNA or desoxyribonucleic acid) and holds the secret of heredity.

The synthesis of RNA was made possible by an enzyme called polynucleotide phosphorylase, which is able to weld together all the small molecular parts that make up the long-chained RNA molecule.

The enzyme was isolated by Dr. Severo Ochoa, New York University-Bellevue Medical Center. It has been extracted from several kinds of bacteria, plants and yeast.

The synthetic RNA has been formed by adding this enzyme to a water solution of the four bases of nucleotides. These nucleotides, when strung together in a very special way, make up the long RNA molecule. The nucleotides themselves are formed by a combination of sugar (ribose), phosphate and any of the four chemical bases, adenine, guanine, uracil and cytosine. Nature carries on life by transferring energy-laden phosphate groups into, out of and between these nucleotides.

The RNA molecules that have been produced in the laboratory appear to be either identical with nature's RNA, or at least very similar to them. The synthetic molecules behave in much the same way as natural ones do in sedimentation tests, structure studies, and X-ray diffraction tests.

But there is no way at present of being absolutely certain that these synthetic molecules are exactly the same kind that nature builds. The bacterial enzyme used in the laboratory has been able to make a copy of nature's RNA molecule by using any one of the four chemical bases. Nature, on the other hand, uses all four of them and in special amounts, Dr. Leon Heppel, National Institutes of Health, Bethesda, Md., explained to Science Service.

"We must still learn how to make the specific RNA that nature does," explained Dr. Heppel, who carried on a joint study of the chemical composition of these new synthetics with Dr. Ochoa's group. "Although we can duplicate the mechanics of nature's construction now, the process is still a wild one. It is almost like a cancerous growth which we will have to learn to control before we can create an RNA molecule with the right bases and biologic activity."

Other scientists taking part in the research included Marianne Grunberg-Manago, Priscilla J. Ortiz, R. C. Warner, Sanae Mii, M. C. Schneider, D. O. Brummond and M. Staehelin, New York University, A. Rich, National Institutes of Health, Bethesda, Md., J. D. Smith, Molteno Institute, Cambridge, England, and R. M. S. Smellie, University of Glasgow, Scot-

land. The research was supported by the American Cancer Society, National Institutes of Health, Office of Naval Research, New York University College of Medicine, and the Rockefeller Foundation.

Germs Dangerous

➤ A "TRANSFORMING CHEMICAL" that can make harmless bacteria change into virulent or disease-producing bacteria has been separated from virulent bacteria by Drs. Deana T. Klein and Richard M. Klein of Columbia University and the New York Botanical Garden, New York. Their transforming chemical is DNA (desoxyribonucleic acid) which, along with protein, makes up some viruses and the genes of cells. These genes carry hereditary factors from one generation to another.

The scientists worked with both the virulent and non-virulent strains of a bacterium called Agrobacterium tumefaciens. Only the virulent strain produces tumorous growths in certain plants, but when the DNA extracted from this strain was added to the normally harmless non-virulent strain, it too was able to cause plant tumors.

The harmless bacteria take up the DNA chemical and add it to one or several clusters of their own genes, the researchers reported. Then, this added DNA becomes a permanent part of the once-harmless genes, and they become disease-producing ones.

Non-Slip Cotton Gauze Bandage

➤ A STERILE cotton gauze roller bandage that is self-fitting, self-tightening and non-slipping—it won't roll away if you drop it—now is available at drug stores. Because it will stretch 40% and then return to its original shape without losing any of its elasticity, it is particularly useful for easy bandaging of knuckles and other joints.

The bandage was first developed by Charles F. Goldthwait and James H. Kettering of Southern Regional Research Laboratory, U.S. Department of Agriculture, New Orleans.

They developed a process for preshrinking cotton gauze. They saw the gauze fibers become kinky and stick to each other as layers of gauze came into contact.

They knew they had a wonderful new bandage. But they also knew that existing Government facilities could not overcome the technical problems of mass-producing the gauze.

In 1952, Government officials approached Johnson & Johnson, surgical dressing manufacturers of New Brunswick, N.J., and asked, in effect, "Can you put this bandage into commercial production?" The firm's researchers accepted the challenge. Their ingenuity produced a series of new machines that carried the raw cotton through several operations without stopping, culminating in the finished bandage. The chief technical problem was how to carry the wet gauze through the machines without stretching it, for stretching would cause the wet bandage to lose its elasticity. By floating the gauze through, this major hurdle was cleared.

Gamma Otherwise Wasted Utilized For Materials Testing

Stored Cobalt 60 Radiation Used

➤ RADIATION FROM cobalt 60, that otherwise would be wasted, is being used at Oak Ridge National Laboratory for useful purposes. The cobalt 60 slugs awaiting shipment to customers after manufacture in the Oak Ridge reactors is the source of the radiation utilized for treating various kinds of substances.

The new unit makes space available in the sub-surface cobalt-60 storage installation for irradiation of materials in an intense gamma field. One feature of the new unit is that samples can be irradiated in air rather than under water, as is done with many gamma irradiation devices now in operation.

Cobalt 60 decays with a half-life of 5.3 years. This new facility is designed to utilize the radiation energy from cobalt-60 slugs awaiting shipment to customers. Under normal storage procedure the benefit of this radiation would otherwise be lost. The radiation field from 85,000 curies of cobalt 60 now stored in the unit has been measured at 1,100,000 roentgens per hour. Since it is expected that the amount of cobalt 60 in storage will vary between 85,000 curies and 300,000 curies, the gamma field will be recalibrated as the loading changes.

Materials to be irradiated are placed in a 10½ in. by 10½ in. by 12 in. space at the bottom of a 5½ ft. long concrete shielding plug. Access to the space is through a maximum clear opening 8½ in. by 8½ in. cross-section. Once samples have been inserted in the compartment at the base of this plug it is lowered into the unit and these samples are exposed to the intense radiation field. Samples requiring special connections, as in a circulating loop system, cannot be irradiated at the present time because of the design of the shielding plug. However, two tubes are provided in the plug for leads to instruments in the irradiation zone.

The cobalt 60 slugs are stored in ninety-two stainless steel tubes arranged in a square pattern surrounding the irradiation chamber. The entire unit is below ground, with a top shield composed of high density concrete and lead. Removal of the heat generated by absorption of radiation in the tubes, shield, and samples being irradiated is accomplished by an air stream flowing through the plenum around the tubes. It is estimated that almost 5,000 watts, or enough to heat two rooms of an average house, will be generated by the radiation heating at a loading of 300,000 curies.

The jig used in construction of wings for a modern transport is so large that workers using the tool must communicate by telephone.

It was recently discovered that the toadfish contains a chemical now in the process of investigation toward the treatment of diabetes.

Acetysalicylic Acid Most Widely Used As Cheapest Drug In Medical Work

The Story of Aspirin

by CARROL A. HOCHWALT
Vice President for Research and Development, Monsanto Chemical Company

➤ THE CHEMICAL INDUSTRY today is conspicuously an industry of plastics and paints, of synthetic detergents, fibers and fluids, pesticides, preservatives and such. Half-hidden by this torrent of modern products, however, is the industry's steady and vital output of what we in the industry call "fine chemicals," including all of the medicinals and pharmaceuticals. These compounds, for the most part, were wrested away from monopolizing European producers in the early years of this century to form the basis of an American chemical industry. They are also a gratifying, challenging and historically important bond existing between the professions of chemistry and medicine.

Nothing could better exemplify that bond between the test tube and the stethoscope than does the colorful history of acetylsalicylic acid. Hippocrates himself, you may know, prescribed a salicylate when he recommended willow bark as a pain-killer more than 2,300 years ago. Slightly more than 100 years ago, the German chemist Hermann Kolbe made chemical history when he successfully synthesized salicylic acid. And, in the grand tradition of chemistry, he gave to medicine an effective palliative and antipyretic while looking for something else!

The story begins a bit earlier than that, however, with a Glasgow surgeon named Lister who learned of the disinfecting properties of carbolic acid and began using it in antisepsis. After he had succeeded in saving the life of Queen Victoria by liberal applications of carbolic acid to her surgical wound, the practice gained in popularity with surgeons. No report is available on the reaction of patients but, knowing the potency of the compound, we can assume that they responded actively to the therapy!

Carbolic acid (which we know as phenol) was just too strong an acid for the liberal medical use which was pioneered and practiced by Lister. In Germany, a surgeon who hoped to find some way of using carbolic acid *internally* on his patients to combat their diseases took the problem to Hermann Kolbe, professor of chemistry at the University of Leipzig. This was in the 1870's.

Kolbe figured that he had just the answer. He recalled how, 20 years earlier, he had succeeded in synthesizing salicylic acid from carbolic acid and the fact that it slowly broke down in the test tube and became carbolic acid again. Surely it would do the same thing in the human body and thus kill off the disease germs.

Fired with the idea of perfecting a germ-killing successor to carbolic acid, Kolbe busily perfected a commercial-

➤ MONSANTO's 100 *millionth pound of aspirin (acetylsalicylic acid) is all in a day's work as Chief Operator A. H. Mueller and Operator J. J. Hess package the milestone batch in the company's John F. Queeny Plant at St. Louis on November* 28. *Aspirin is the most widely used and the cheapest (at one-half cent per tablet) drug in the world, and Monsanto is the world's leading producer of it. Current aspirin consumption in the United States is at a rate equivalent to* 50 *million five-grain tablets daily.*

ly practical synthesis for salicylic acid by reacting carbon dioxide with sodium phenate under heat and pressure. (A process, by the way, which still is in use today with but minor refinements.) His assistants tested the compound crudely on a variety of microbes and bacteria and obtained encouraging results. When the news was made public in 1874, doctors clamored for the new salicylic acid "germ killer" and its use spread rapidly. It was applied liberally to cuts and wounds (where it actually did promote healing) and also was administered internally for any and every kind of disease. It was even taken up by food manufacturers and

used as a preservative in their products. Kolbe was so confident of his new "germ killer" that he is reported to have encouraged one of his students to go into business with a small salicylic acid plant. The student's name was Heyden and you may have heard of his chemical company.

Within a year, however, doctors began reporting the fact that dosages of the salicylic acid, while seeming to help their patients, didn't really effect any cures. It would reduce their fevers and relieve their pains but it failed to stem the diseases or their fatal toll.

A young Swiss physician named Carl Buss pondered carefully over the bewildering performance of the drug. Victims of typhoid, pneumonia and all of the other diseases responded similarly to salicylic acid. Whatever the cause of their fevers, the compound promptly and dramatically reduced them.

Then, from Berlin's Dr. Franz Stricker came the further report that salicylic acid not only reduced fever but relieved the pain and swollen joints of rheumatism. Following these came more reports confirming the compound's palliative effect not only for the rheumatic and diseased but for those suffering the pains of neuritis, neuralgia and headaches.

Hermann Koble had failed to find the germ-killer which his theory had predicted; he had found only an effective, economical and easily obtainable antipyretic, analgesic and antirheumatic!

Heyden's salicylic acid plant in Dresden was doing a capacity business as demand soared for the compound. At Dusseldorf, the order of the day for Friedrich Bayer and Company's chemists was to find a compound competitively superior to Heyden's. And there was room for improvement, too, for salicylic acid frequently produced nausea and other symptoms almost as discomforting as the pains which it was to relieve.

A young staff chemist at Bayer named Felix Hoffmann had another good reason for seeking a successor compound in addition to his employer's orders. His father was racked with pain of rheumatoid arthritis and desperate for a palliative which would be less irritating than his salicylic acid.

Hoffman searched for likely compounds among the records of chemical oddities and misfits and, there, ran across acetylsalicylic acid. The compound had been discovered in 1853 by Charles Frederic von Gerhardt who had reported it as a novel but useless derivative and abandoned it to a 46-year obscurity until Hoffmann's chance encounter of it.

Heinrich Dreser was director of Bayer's pharmacological research and a scientist of great prominence in Europe. Hoffman prepared samples of pure acetysalicylic acid, tested them in the laboratory and on his long-suffering father and, convinced that he had something, laid the compound and his data before *Herr Doktor.*

Dreser's clinical evaluation of the compound proved it to be outstanding in all respects. Only one thing was wrong with it: its chemical name was hard to pronounce and sounded entirely to much like the salicylic acid it would have to meet and beat in the market place. But Dreser remembered that natural salicylic acid orig-

inally had been extracted from plants of the spirea family and, for that reason, was known also as spiric acid or *spirin*. He added the "a" from acetyl to the latter and coined the name for Bayer's newest drug: Aspirin.

Carefully protected by patents, Bayer enjoyed an immensely profitable 17 years of world monopoly in aspirin sales, marred only by the occasional infringement of *entrepreneurs* who could not resist the temptation to risk a little bootlegging of acetylsalicylic acid into the channels of pharmacy.

During the 40-year period dating from Kolbe's commercial synthesis of salicylic acid in 1874 to the eve of World War I, Germany held a virtual world monopoly in synthetic drugs and in the intermediate chemicals necessary for their manufacture. It was an era of pharmaceutical discovery dominated by such palliatives as the salicylates, antipyrine, antifebrin, phenacetin and, last and best, aspirin.

Bayer's United States patent on aspirin expired on February 27, 1917. Monsanto and other American chemical companies had plant facilities for aspirin in readiness for this expiration. Little more than a month later, in April, 1917, Monsanto became the first independent producer of aspirin in the United States, joined shortly there after by several other chemical companies.

You may be interested to learn that Monsanto was established originally as a producer of fine chemicals and remained as such for nearly 25 years. Monsanto Chemical Works was founded in 1901 by John F. Queeny, then purchasing agent for Meyer Brothers Drug Company here, to produce saccharin, available up to that time only from Europe.

The retaliation by the powerful saccharin producers abroad to this effort by an American upstart was swift and severe. The imported price of saccharin, which had been approximately $6 per pound was slashed as low as 60 cents per pound in an effort to drive the infant Monsanto company out of business.

Instead of quitting the field, however, Monsanto responded by going into the production of still other fine chemicals in competition with Germany's chemical Goliaths. Vanillin and caffeine were added to the Monsanto line, then acetophenetedin, chloral hydrate, phenolphthalein, glycerophosphate salts, coumarin, acetanilid and phenol. In most cases, Monsanto was the first company to produce these chemicals in the United States.

Meanwhile, late in 1912, Dr. Gaston DuBois of Monsanto had visited a prominent chemist in Switzerland and purchased from him, for 2,000 Swiss francs, a process for making pure acetylsalicylic acid in one operation. After a thorough test out of the process, Monsanto built a plant for the process in 1916. The company produced and sold 2,368 pounds of the product in 1917.

Bayer, of course, fought hard both before and after its patent expiration to reserve for itself exclusively the use of the name "aspirin" for acetylsalicylic acid. The company claimed that Dr. Dreser's cleverly coined name for the product was a trademark of Bayer and that, while anyone could make aspirin following the patent expira-

tion, only the production of Bayer could be called by that name.

This led to considerable pamphleteering, editorializing and court-fighting by parties on both sides of the issue with Mr. Queeny strongly leading the opposition to Bayer's view. In November, 1918, the Patent Office cancelled Bayer's registration rights to the name as having been improperly and unlawfully registered. The last hurdle had been cleared, and U. S. chemical producers definitely were in the aspirin business. Monsanto's production rose in 1919 to 480,874 pounds.

Dr. Jules Bebie, then chemical director of Monsanto and in charge of its research, wrote in a report on early aspirin production that is in our archives: "All in all, the development of this department was a series of disappointments and costly experiences. But with the information gained and with our present process and installation we should be in a position to be the leading factor in this article and to make up for the losses connected with the development."

It was a prophetic pronouncement, for Monsanto has indeed become the world's leading producer of aspirin.

Sales of aspirin continue to rise with our expanding populations and with the confirmations and discoveries which continue to come from research into the pharmacology and clinical use of the drug.

There still is much to be learned, I understand, of the compound's mechanisms of action. How does it do what it does for the rheumatic and arthritic sufferers? Why does it reduce abnormal body temperatures while having no effect upon normal temperatures? Just what is the means by which aspirin succeeds in moderating pain? The answers to these questions are sure to come in time, I believe, and with them may come still more important applications for this cheapest, safest and most perennially durable of the genuine "wonder" drugs.

Silicon-Olefin Compounds

➤ COMBINING olefins, derived from petroleum, with silicon forms a whole series of products similar chemically to the silicones.

Silicon, combined with an organic group and one or more atoms of fluorine, takes part in the reaction in the form of a "free radical," Drs. A. M. Geyer and R. N. Hazeldine of Cambridge University has announced in the journal *Nature* (Oct. 13). They add that the particular product desired can be controlled easily by regulating the proportions of the chemicals used. Further addition of one of the elements, such as fluorine, can be accomplished just as easily by their method.

Possibility of using a modification of the same method for creating similar compounds of other elements is foreseen by the Cambridge chemists. They mention bismuth, germanium, lead, zinc, phosphorus, arsenic, tin and aluminum as those they are studying with "reasonable certainty" that the free radical behavior will resemble that of silicon. But "it is equally clear," the authors state, "that certain of these will be stable only at relatively low temperatures."

Our Atomic Future

by Dr. Willard F. Libby,
Commissioner, United States Atomic Energy Commission.
Remarks on the occasion of the dedication of the Research Reactor at the Naval Research Laboratory, Washington, D. C.

➤ We meet today to formally dedicate this, the first reactor in the District of Columbia or its immediate environs. Many more will follow throughout the United States and the probability is that this will happen soon. The benefits your reactor will bring you will be so real and promising that as in most other instances you will become salesmen and promoters for the new installations. The magic of the transformations of atomic nuclei, which release atomic energy, imparts itself in part to those who work in the atomic field, and the powers of persuasion of this group thus become great. The experience of using a reactor convinces one of its great potentialities and the desirability of having others learn about atomic energy. We congratulate you on your wisdom and foresight in undertaking this project and hope you enjoy a large measure of success in passing along to others the knowledge you will acquire in the operation of this reactor.

The known peaceful uses of the atom, of which peace itself is probably first, are manifold and are coming to be widely recognized as being of great benefit to mankind — even before atomic power, which certainly is one of the principal uses, has been fully achieved. In fact, it is becoming clear that the American taxpayer will shortly be receiving benefits from the industrial uses of isotopes which alone will pay good interest on all the money he has invested in atomic energy — our atomic armament, the great advances in scientific knowledge due to research made possible by atomic energy, and atomic power itself all being carried by this relatively uncelebrated peaceful use.

Despite the greatness of this story, I would like to tell you today about some of the peaceful uses. Great as the uses already made are, it is certain that these are by no means all of the applications of atomic energy than can and will be made. The unborn uses must be numerous and probably in some instances very important. Let us consider what some of them may be and how best to improve their chances of being born.

Low-Level Radioisotopes

Of course some of the presently envisaged uses have been applied on such small scale that we can hardly say that they have yet been born themselves; e.g., the everyday use of isotopes at low levels in medicine and industry has not really been realized and as stated earlier this may well be one of the principal peaceful uses in the final analysis. Let us say that the everyday use of isotopes in the exact

quantity range of magnitude — the purposeful introduction of tiny safe amounts of radio-activities into industrial processes and in the diagnosis of the ailments of the human body — will develop to a much greater importance than they now have. Cheaper methods of synthesis of the chemicals must be developed, perhaps these will be by biosynthesis, the isotope farm, etc. Superior methods of measurements of the radiation, in most instances so soft as to render most instruments now on the market unsuitable, must be accentuated. Instruments of the requisite sensitivity and which are cheap and serviceable must be produced in large volumes. Probably every high school science classroom in the country should have such an instrument, every doctor's office, and most industrial plants. It is clear from the electronics of radiation detection instruments that there is no reason why their cost should be greater than that of a cheap radio set when produced in adequate volume. This development of cheap sensitive instrumentation will unlock the door to one of the principal peaceful uses of the atom, the everyday use of isotopes.

Thermonuclear Power

Another major effort is underway in an energetic attempt to harness the thermonuclear reaction for power purposes. In this country this is known as Project Sherwood. The fantastic temperatures required to support the thermonuclear reaction make the problem enormously difficult and it seems clear that there is little chance of success in the immediate future, but it also seems clear that a number of incidental benefits will begin to accrue soon. For example, we are learning about the properties of the ionic plasmas generated in every electrical discharge and how they can be moved and contained by magnetic fields. In other words, properties of matter at the extreme temperatures necessary to fusion reactions among the hydrogen isotopes are beginning to be understood.

It is an elementary consideration that there are enormous quantities of energy in the deuterium or heavy water contained in ordinary water, and that if we could economically unlock this energy the world would really have achieved essentially an inexhaustible supply of energy. However, just as in the case of the fission reaction, the harnessing of the energy is no mean task, and relative to the case of the fission reaction we have in this instance much farther to go. We actually have piles operating and atomic power plants working. It is a question of improvement and further development.

In the case of the thermonuclear power plants, however, we have never seen one and have only successfully conducted the operation under conditions where no serious containment is needed, namely, thermonuclear weapons. In these, events occur so rapidly that the reaction is over before time for expansion has passed. In other words, the containment problem is avoided in its essence. The question is how can one maintain hydrogen and deuterium gas at enormous temperatures in a terrestial environment — the temperature being high enough so that the collisions in the ordinary course of events will lead to the nuclear reactions and the un-

locking of the enormous fusion energy which amounts to some four million electron volts per gram of matter transformed, in contrast to the fission reaction which involves only one million electron volts per gram of matter transformed.

It is an attempt that we all must encourage for in it lies possibilities of discoveries of great importance not only for the generation of electric power, but for untold other things which will follow from the necessary new fundamental understanding of nature. We have never understood or known very well the properties of matter at high temperatures. It is certain that this will help us. At a conference in Geneva, Switzerland, it was suggested that the properties of plasma were such that plasma in the shape of a donut and a few feet in diameter might be used to replace the enormous electro magnets weighing many thousands of tons which now are used to define the race tracks for the acceleration of the protons to energies of several billions of electron volts as in the most modern accelerators.

The real question is whether the same information can be obtained in some other way and the answer, of course, is that if good people are interested in working on Project Sherwood, Project Sherwood should be strongly encouraged, but if only people of lesser ability can be interested, the enormous amounts of money which will be involved should be somewhat more circumspectly allocated. In work of this sort ability and understanding is the most important matter. No one could hope that the control of thermonuclear energy will be achieved in any other way and it is a problem and a task of sufficient challenge and nobility to attract the ablest people.

Chemistry and Radiation

A plastic can be produced by polymerization reactions which are induced by the free radicals generated by radiation. These are in many ways superior or at least different from those produced by free radicals generated by chemical means. We all know that mutations are caused by radiation. We all know that death and damage of many subtle kinds can result from it. Certainly it is true that all of these are manifestations of what may be known as Radiation Chemistry and Hot Atom Chemistry. Further understanding of the laws of these subjects will undoubtedly lead to new peaceful uses. Radiation in the first instance acts primarily in two ways. Whether it be alpha, beta, or gamma radiation, it acts by stripping electrons from the atoms and molecules of the matter traversed. The ions so produced then proceed to react or decompose either as ions or subsequent to the recapture of an electron to form an excited neutral molecule. The second way in which radiation from a pile can act is via the neutrons. This is an entirely different mechanism in that the neutrons collide with the atomic nuclei and cause them to recoil in many instances with velocity insufficient to ionize them. Therefore, we should expect wholly different physical chemical phenomena for two kinds of radiation. In particular, the generation of chemical reactions by neutron irradiations may well lead to entirely different results. Similarly, the gene-

tic effects might be different. Little is known about these fields and it is quite clear that the possibility of further study revealing important peaceful uses in these fields are real. To date too little has been undertaken in a fundamental way. It has been more a matter of understanding so as to avoid nuisance effect rather than understanding as an end in itself. It is to be expected that if we really can understand the chemical properties of an ion formed by removing an electron from a stable molecule, or if we can really understand the chemical behavior of an atom that has been thrown forward at high velocity in a certain environment as a result of collision with a fast neutron, we would undoubtedly unlock important new peaceful uses.

The Chemist's Role

The role of the chemist in atomic energy is one which has not yet grown to full bloom. The chemist's broad understanding of the properties of matter, his experience with its behavior and idiosyncrasies, make it apparent that he will be important in the discovery of new uses of atomic energy. There has been a certain tendency for the industrial chemist to stay with his own present work and at most to use isotopes for purposes of research and understanding of ordinary chemical phenomena. Only a few groups have enthusiastically attempted to use radiation and isotopes and atomic energy for ordinary chemical purposes. Their success, however, together with the broad general theoretical possibilities lying in the fields of Radiation Chemistry and Hot Atom Chemistry make it seem extremely likely that there will be considerable developments in the chemical fields.

The Atomic Energy Act of 1954 places the responsibility for the development of the peaceful uses as well as for the military uses squarely upon the Atomic Energy Commission and so all of the unborn uses which have promise will have support from the Commission. It should be clearly understood that the great possibilities of invention of new uses and the invention and nurturing of new ideas in this respect are considered by the Government to be important. The young scientist entering the field can well consider this a goal worthy of him and hope to be rewarded for successful efforts.

Science Is Our Frontier

People are beginning to understand more clearly how it is that the science and invention of peaceful as well as warlike devices have brought us the material well-being we now enjoy. There is only one continent as yet unexplored and so long as we remain earthbound there will be no more. Throughout the hundreds of years lying ahead of us the real frontier will not be geographical but must be our understanding of nature and her laws. The better we understand nature, the better she will treat us. The more we know the better we can live. And so the young scientist and engineer is the modern soldier of fortune; the modern discoverer of new lands and new things; and the source of new benefits through his extension of human understanding and knowledge. We have seen that military power has turned in large measure on these people. We have learned that education and scientific acumen are

essential to modern military victory and looking back over history it is clear that this is nothing new. It is just that it has come into its own. From the time of Archimedes onward we have seen how important invention and understanding of natural phenomena has been in determining the balance of power in the world.

Though material well-being is only part of our happiness; it is an important part; and we can understand how it will help us to have the time and leisure to cultivate the humanities and to foresee the trend of events so that wise political decisions can be made. The relative ease with which a living will be made in the future will liberate a large part of mankind and give it the freedom which was so necessary to the great culture the old Greeks developed on a leisure derived from slavery. Our slave will be the atom and our understanding will harness him and keep him working for us. In this way we will be able to develop the history and the arts. The world's future holds promise of a blossoming of the arts and humanities in ways which the world never before has seen. Not only will science progress but so will all forms of human intellectual endeavor, and this may come to rank next to peace as the second of the peaceful uses of the atom.

Fluorescence Detects "Wobbly Molecules"

➤ INSIDE information as to whether molecules of a chemical are rigid or, instead, have "molecular wobble," can be gained through use of fluorescence phenomena.

Dr. William West, of Kodak Research Laboratories, before the Indianapolis Section of the American Chemical Society recently, said that fluorescence, which is the emission of radiation during absorption of other radiation, provides one of the most sensitive tests to determine the presence of a chemical. Through its use, scientists can in some cases note the presence of as little as one ten-billionth of a gram of one substance in a single cubic centimeter of another.

In biological use, the Eastman Kodak scientist said, this means that a very small amount of a substance can be detected in a body liquid such as blood plasma.

Geologists have used fluorescence to trace the flow of underground waters, he said. He cited one test in which a fluorescent material, thrown into the headwaters of the Danube, appeared some 40 miles away in the Rhine, although there was believed to be no direct underground connection between the two rivers.

In the study of molecular structure, Dr. West pointed out, it has been learned that some molecules are organized in a rather rigid arrangement, while others can move or wobble with a flopping motion.

It is the rigid molecules that fluoresce, he said, and chemists have found that fluorescence can be increased in a substance by increasing the rigidity of its molecules. Some dyes that do not ordinarily fluoresce can be made to do so, he said, by coating them on a fabric to make their molecules more rigid.

Human Blood Group A Substance Is Nitrogen-Containing Disaccharide

Blood Discoveries

➤ IF YOU belong to blood group A, you have a special kind of sugar chemical in your body. Human blood group A substance has been studied chemically and found to be a nitrogen-containing disaccharide. Disaccharides are the class of sugars to which ordinary table sugar and milk sugar belong.

By heating human blood group A substance with acid, scientists at the Lister Institute of Preventive Medicine, London, extracted five disaccharides that contain nitrogen. In further tests, including some with human anti-A serum, the scientists pinned the substance that is blood group A fairly closely to a chemical called O-alpha-N-acetyl-D-galactosaminoyl-galactose.

The studies are reported by Drs. Raymond H. Cote and W. T. J. Morgan in a recent issue of the British scientific journal *Nature*.

Dissolves Blood Clots

➤ FEVER-PRODUCING chemicals and an enzyme, or activator, from urine are being tried as speedy agents for dissolving dangerous blood clots inside blood vessels.

The American Heart Association reports that "very encouraging" results in treatment of more than 50 patients with the fever-producing chemicals have been obtained by Dr. Kurt N. von Kaulla of the University of Colorado Medical Center, Denver.

A blood clot inside an artery can cause a heart attack or a "stroke," as most persons today know. Anticlotting medicines help control the condition, so that there is less likelihood of further clots forming. Needed now is a method for more prompt and effective dissolving of clots already formed. Ordinarily, it may take days or even weeks for a sizable clot to be dissolved. Meanwhile, the body is simultaneously carrying out another repair process which involves the laying down of scar tissue. This is ordinarily a protective mechanism but it may harm the inside of a blood vessel by narrowing and distorting the inner surface. Doctors would like to dissolve clots quickly and completely to help restore normal circulation as fast as possible.

The fever-inducing medicines, called pyrogens, are of bacterial origin; they act in humans but not in animals or test tubes. The enzyme is called urokinase.

Streptokinase

➤ ANOTHER enzyme called streptokinase, which is derived from some streptococcus germs, may also prove useful for safely dissolving clots in the human blood stream. "Some beneficial results" when streptokinase was infused into the veins of 23 human patients were reported by Dr. Sol Sherry of Jewish Hospital, St. Louis, at a recent conference of the New York Academy of Sciences.

Much work needs to be done be-

fore significant conclusions can be drawn, Dr. Sherry said. He reported some undesired side effects such as fever. Some of the favorable results may have been due to natural repair by the body. Streptokinase is known to have an anti-inflammation property. It may be that it was this, rather than a direct effect on blood clots, that caused the benefit to the patients.

Earlier study of the enzyme was made in the test tube and in animals. Streptokinase dissolved clots in 13 of 26 animals, compared to 10% disappearance of clots in animals not treated and 9% in animals given another enzyme.

Hemoglobin Varients

➤ HEMOGLOBIN, the chemical that gives blood its red color and carries oxygen throughout the body, exists in many abnormal forms. A total of at least 12 variants of human hemoglobin have been characterized well enough so as to be considered distinct, Dr. Wolf W. Zuelzer of Detroit told a meeting of the International Society of Hematology in Boston, Mass. They are known as: A, F, S, C, D, E, G, H, I, J, K and Liberian II.

(These hemoglobin varients should not be confused with the blood group substances, A, B, AB and O, used to type blood for blood transfusions.)

With the exception of F and H, the hemoglobin varients are genetically controlled. Normal hemoglobin is known as hemoglobin A.

The possibility exists that some hemoglobins now designated by the same letter, such as G, H or J, may prove to be separate entities. This would confuse the present system of naming the hemoglobins.

The different hemoglobins have a geographic distribution. Hemoglobin S is found all over tropical Africa and in Mediterranean countries and in the New World in populations derived from these locations.

Hemoglobin C is now found very frequently only in West Africa and can be found wherever West African slaves were brought in the past.

Hemoglobin D, until recently considered rare, is found in single families in America, Europe and Africa but recently has been found a constant feature in the Punjabis and Gujeratis of India.

Hemoglobin E is found as often as in 10% of Siamese and Burmese, less often in Indonesians, Bengalis and Ceylonese.

Hemoglobins G, H and I have so far been found only in single families.

New Machine Measures Body Blood

➤ A NEW MACHINE that uses radioactive blood cells to determine the amount of blood in the body has been developed by Dr. Salomon N. Albert, clinical instructor in anesthesiology, George Washington University, Washington, D. C.

The "isotope univac" might save the life of accident or surgical cases by giving a quick and accurate estimate of how much blood is left in the body. It makes this life-saving knowledge quickly accessible to the ordinary hospital staff.

To find out how much blood a patient has, he is first given an injection of a salt solution containing red blood cells that have been tagged with radioactive chromium 51. About 15 minutes later, a small blood sample is taken from the patient's arm, put in a coiled plastic tube, and

inserted into the typewriter-sized machine.

Within three to five minutes the machine has measured the radioactivity of the blood sample and computed the total volume of blood in the body. Then the answer turns up and can be read directly off the machine with no further calculations.

Radioactive isotopes have been used before to make blood volume determinations, but the technique was extremely complicated and required "slide rules and calculators" as well as special training.

The new machine now puts these valuable clinical data within the reach of ordinary physicians and hospital technicians. It will also prove a valuable aid to a number of lines of study in medicine and also in industries using radio-isotopes for measurement.

The specialized computer was developed by Dr. Albert and William O. Swann, a former electronic physicist.

Civilization Linked To Invention

➤ THE RISE and fall of civilizations coincides with the rise and fall of the "respectability" of the inventor, Dr. Eugene Ayres of the Gulf Research and Development Co., Pittsburgh, Pa., declared speaking as a Sigma Xi national lecturer.

Dr. Ayres holds 46 patents in a wide variety of subjects and is co-author of *Energy Sources — The Wealth of the World.*

For thousands of years one nation after another has reached its peak of material progress and then has declined, Dr. Ayres explained. The most plausible explanation in his opinion is that in declining civilizations there is a prejudice against technical originality. The inventor or creative scientist was not well thought of in cultures that were on the down grade.

The Roman Empire rose upon a wave of technical achievement, not equaled for 1500 years, he observed. The Dark Ages, on the other hand, were characterized by intense popular feeling against anything new in the way of technology.

Dr. Ayres declared that America has developed technology-based industry with enthusiasm and energy since 1870 but that we have commercialized the inventions of other nationals, as the Japanese have done.

The decline of American fundamental originality is disquieting to Dr. Ayres. He finds that engineers "working toward the dead-ends of perfection and circumstance" have narrowed our margins for future improvement. It is more important now than at any time in the past to select new distant goals of technologic achievement.

"Technologic advance is now more than ever in the public consciousness," Dr. Ayres said, "But the vast majority of today's scientists are engaged not in invention of principles, processes or things, but in development and in various forms of technical service. If it is possible to teach genius instead of merely hoping it will come along, the future will belong to the society that first discovers how."

See Same Mechanism in Allergy, Mental Illness

Anaphylactic Shock Chemical

➤ THE MECHANISM of sudden death by anaphylactic shock, which sometimes hits allergy patients, and the process governing mental illness may be linked.

Evidence for this possibility comes from studies by Dr. Mary Alexander Fink of the University of Colorado Medical School.

A body chemical called serotonin is 1,000 times more powerful than histamine in inducing the violent muscle contractions of anaphylactic shock in the mouse, Dr. Fink found. Anaphylactic shock strikes when a person who has developed special sensitivity like an allergy to a substance, such as egg white or horse serum, gets another dose of the same substance. The shock can be fatal.

Serotonin is found in the brain, intestines and blood platelets. It stimulates voluntary muscle, including the muscles of artery walls, and may raise blood pressure and body temperature. Some scientists believe serotonin acts as switches linking nerve pathways for the passage of stimuli to and from the brain. Some tranquilizing drugs have been reported to release serotonin from storage depots to flood the system. Scientists have also reported that a drug which brings on symptoms of temporary insanity, LSD, short for lysergic acid diethylamide, blocks serotonin.

Dr. Fink has shown that a tiny trace of serotonin will produce shock reactions in mouse smooth muscle suspended in laboratory dishes, and that it takes 1,000 times as much histamine to produce a similar reaction. She showed further that the reaction is completely abolished by adding to the tissue either the madness-inducing drug, LSD, or the tranquilizer, reserpine.

Implications of Dr. Fink's findings are given by the American Cancer Society as follows:

"They show that serotonin is probably the key substance in anaphylactic shock in the mouse. They confirm others' findings that reserpine and LSD act through serotonin. And they open the door to speculation as to the existence of a biological and chemical link between allergy and chronic mental disease."

Dr. Fink's findings are a by-product of her development of techniques for testing for the presence of anticancer antibodies in mice tissues.

The nation's petroleum pipeline system, which began less than a century ago as a five-mile length of wrought iron tubing, is now long enough to circle the earth seven and a half times and will hold 3,000,000,000 gallons.

In each USAF aerial refueling operation, fuel can be transferred at 600 gallons per minute — enough to fill the gas tanks of 38 automobiles in 60 seconds.

India Stakes Her Atomic Program On World's Largest Thorium Deposits

Thorium—India's Nuclear Fuel

by Barbara Tufty

➤ The heavy black sands along the southwest coast of India contain the world's largest known supply of thorium, potential nuclear fuel for industrial power.

Thorium, a radioactive element, is found here chemically bound to monazite, a phosphate of the group of elements known as rare earths. About one and a half million tons of monazite sands lie along the Travancore coast line, according to estimates by scientists at the Indian Rare Earths Limited. Indian monazite is especially rich in thorium, containing from 8 to 10.5%.

Thorium ore has been found in Brazil, Indonesia, Malay, Florida, and in some parts of Russia, but the richest deposit lies on the cocoanut-fringed beach of India, about nine degrees north of the equator.

Along the narrow hundred-mile strip of beach that stretches from Cape Comorin to north of Quilon, curious combinations of nature have worked for thousands of years to heap up the unusual supply of monazite sands.

Washed down from the crumbling Western Ghats by torrential monsoon rains, rich rare-earth minerals have gradually been carried westward towards the Arabian Sea. High specific gravity of these minerals causes them to sink quickly to the bottom of rivers and floods, while lighter materials are borne away. Thus considerable deposits of heavy mineral sands have slowly moved onto the lower beaches of the country. Under usual conditions of erosion they would be washed into the ocean and lost. But here unusual sea currents, sand-bar formations, and the yearly violent monsoon all combine to throw back the heavy sand grains. During the hot tranquil months of summer, silica grains make the beach blinding white under the sun. During the stormy monsoon months, however, southwestern winds whip the sea into churning waves that carry away lighter silica sands and heave black minerals back onto the low dunes.

It only remains for man to dig this sand during the monsoons and separate it into its various components.

The main constituent of the black sand is ilmenite, a compound of iron and titanium oxides. Monazite, source of thorium, forms about 3% of the Travancore beach sand. Other minerals include rutile, zircon, and also sillimanite, garnet and quartz.

First stage in separating sands for nuclear fuel begins at the beach near Chawara, Quilon, where Indian factories separate theorium-bearing monazite from ilmenite by vibrating screens and electromagnetic separators. From there the now green-golden monazite sands, packed in gunny sacks, are poled in flat country boats along the Periyar River and shallow back waters to the Rare Earths fac-

➤ An Indian *riverboat is hand-powered past India's new Rare Earths factory in Travancore-Cochin geared for the atom-powered future. Rich in thorium, India is scooping the radioactive element from her beach sands and processing it in this factory.*

tory at Alwaye about 30 miles to the north, where the second step for nuclear power takes place.

Here in modern gray and white buildings on a 24-acre site, more than 1,500 tons of monazite sands are treated chemically each year to produce rare earth compounds, shining white trisodium phosphate and the thorium residue, a light tan mud.

Alwaye officials estimate that the factory could treat well over 2,500 tons of monazite a year by working double shifts.

Most important to India's nuclear energy program is the residue thorium hydroxide, containing about 9% thorium and a fraction of 1% uranium. This residue is shipped to Thrombay, near Bombay, to produce thorium and uranium compounds and metals for use in atomic reactors and industry.

India will probably rely chiefly

upon thorium for her future nuclear power, Indian scientists predict.

Although thorium is radioactive, it is not naturally fissionable. It can be converted into U-233 which is fissionable. This is done in a breeder reactor where a core of U-235 sends out neutrons into a surrounding blanket of thorium and turns it into U-233, fissionable material for generating power.

This is the most likely process by which India will use her plentiful supply of thorium in her reactors.

The Indian Rare Earths Limited was set up in 1950, following the passage of the Government of India's Atomic Energy Act in 1948, and the establishment of an Atomic Energy Commission with Dr. H. J. Bhabha as chairman. Dr. Bhabha, one of the world's foremost physicists, was chairman of the 82-nation conference on nuclear energy held at Geneva in 1955.

India's valuable monazite deposits were discovered unexpectedly about 50 years ago by a chemist in a warehouse in Germany. In the early years of this century, coir or rope spinners were carrying on a lively trade with Europe, especially Germany. As coir spinners sat on the Travancore beach to twist their cocoanut-husk rope, heavy wet sand grains became entwined. Much of this sand fell off on the voyage, but some stuck long enough to reach the coir storerooms of Germany. In 1909 a German chemist chanced to analyze the yellow-green sands and found high quantities of monazite.

From there on, the beaches of Travancore were sifted, agitated, separated and exported without restriction until 1947 when a small group of scientists approached the president of the Indian Science Congress and convinced him to halt the foreign development of India's valuable minerals. That president was Jawaharlal Nehru, and today the industry is under control of the Government of India, performing an important part in India's declaration of economic independence.

Arthritis Drug Lifesaving in TB

➤ PREDNISOLONE, recently developed as an anti-arthritis drug, can save lives of tuberculosis patients when used with anti-TB drugs such as a streptomycin and isoniazid, Dr. Harry Shubin of Philadelphia General Hospital has reported.

Its life-saving effect appeared in patients with acute forms of tuberculosis that had attacked the brain and spinal cord or had spread all through the body.

In chronic tuberculosis in which the germs have grown resistant to anti-TB drugs, prednisolone proved helpful in converting the patients to a non-contagious state.

In another group of 40 patients with far advanced tuberculosis of the lungs and who stopped improving after one or two courses of treatment, 22 showed further improvement when prednisolone was included in the treatment. Adequate anti-TB treatment must be given at the same time that the prednisolone is given. The prednisolone preparation used has the trade name Sterane.

Chemical Mechanism Points to Control of Excess Cholesterol

How Body Creates Steroids

➤ THE CHEMICAL steps by which nature manufactures the steroids, one of the most important compounds in man, animals and plants, have been charted for the first time by a group of University of California scientists.

This is the third major class of compounds whose pathway of synthesis in living systems is now fully understood. The other two classes are fats and carbohydrates. The new work may expand man's knowledge of the human body and other biological systems as much as the earlier charting of the fat and carbohydrate biosynthetic pathways.

Already the research has touched off speculation that chemical blocking agents might be used to prevent the formation in the body of excess cholesterol, a widely distributed steroid which is associated with hardening of the arteries in man. With the complete chemical cycle now known, it may be possible to find a blocking chemical that would interfere with a specific step in cholesterol formation much as sulfonamides interfere with infection.

In addition to cholesterol, other steroids in man include such chemicals as cortisone, sex hormones, and vitamin D. Digitalis, used in heart conditions, is an example of a steroid in plants.

The new work shows that all the steroids, whether in plants or animals, evolve chemically in the same way, each steroid achieving its distinction by a slight last-minute differentiation in arrangement of outer atoms in a large parent molecule.

The new cycle was clarified in six years of work by Dr. William G. Dauben, associate professor of chemistry, with the collaboration of John H. Richards, Thomas W. Hutton and Yoshio Ban.

Scientists have attempted to chart the steroid chemical pathway for 20 years, but the schemes suggested all failed. In 1950 scientists in England and Switzerland noted a link between the steroids and a group of chemicals called triterpenes. This provided the clue which made it possible for Dr. Dauben to work out the complete pathway.

The scientists showed that steroid construction begins with acetate, a simple chemical unit widely distributed in plants and animals. In man, acetate is a common by-product of the body's burning of fatty acids contained in the diet.

The acetate is converted, in a series of steps, into isoprene-like compounds, a class of chemicals that form the basic units of rubber. The isoprene is turned into squalene, found first in shark liver 30 years ago and now known to be universally present in biological systems. Squalene is converted into triterpene, which is turned into steroids. Cholesterol has the same structure as a triterpene molecule except that it has lost three carbon atoms.

The chemical steps are achieved by chemical synthesis performed by specialized enzyme systems in plants and animals. Minor differences in the placement of carbon atoms on the edges of the large parent triterpene molecules make the difference between cholesterol, hormones and other steroids.

Dr. Dauben and his colleagues did their experiments by "feeding" acetate, containing radioactive carbon 14, to living liver slices in test tubes, to yeast and to eucalyptus wood-rotting fungi. The carbon 14 was traced from step to step, and in this way a picture of the biosynthetic cycle was built up.

Look Farther into Space

➤ A NEW light-intensifying device that will allow man to look three times farther into space with the world's largest telescope, the 200-inch on Mt. Palomar, is now in the preliminary stages of development at Westinghouse Research Laboratories.

The biggest reflector will become the equivalent of a mirror 2,000 inches in diameter. This is made possible by an image multiplier that in six simple stages of electron enhancement will take the light of the Palomar telescope and increase it 10,000 to 20,000 times in brightness.

The volume of space to be reached will be some 27 times that now visible. This means that instead of being able to see back two to three billions of years in light time travel, astronomers will probe six to nine billions of light years.

Most important to theories of the constitution of the universe will be new knowledge of the distribution of the galaxies in distant space. Perhaps the moot questions of whether there is an end to spece or whether space bends back upon itself will come closer to solution.

It will be at least several years before the device being pioneered by Dr. E. J. Sternglass and Milton Wachtel will be attached to the 200-inch telescope.

But a model has been built and the principles seem quite clearly worked out. Light is picked up on an electronic screen that gives out four electrons for every one that hits it. This is repeated in six stages.

An early development of the device will probably be used on smaller telescopes in connection with the International Geophysical Year.

Devices relayed to the image multiplier will allow more ability to see in the dark. These will have military and security applications. It should be able to watch an area at night without lighting it and military movements could be spotted at night from the air despite darkness that prevents ordinary photographs.

Leading edges of the wings of a new U. S. supersonic jet fighter are so sharp they must be covered with rubber "gloves" to prevent ground crews from cutting themselves while the plane is being serviced.

The world's oldest corn experiment field, in continuous use at the University of Illinois since 1876, is showing how to renew worn-out soils.

Amino Acids Made Out of Primitive Atmospheric Gases

Origin of Life Chemicals

➤ LIGHTNING discharges in the early days of the earth, some three billion years ago, could have produced from atmospheric gases the materials out of which life arose.

In his laboratory, using relatively simple spark coil discharges, Dr. Philip H. Abelson of the Carnegie Institution of Washington's Geophysical Laboratory has manufactured amino acids, building blocks of protein, out of carbon dioxide, nitrogen, hydrogen, water and ammonia in various combinations. This imitation of the possible happenings in the primitive air of our earth when young is part of an attempt to reach back into earth history and see what could have happened then.

At a recent National Academy of Sciences meeting, Dr. Abelson said there is evidence that the earth's atmosphere half a billion years ago was not much different from what it is today.

One school of scientific inquiry has suggested that the earth came alive from the original envelope of gases that survived from the formation of the earth out of the primordial matter of the universe. Dr. Harold C. Urey of the University of Chicago upholds this view and his experiments with Dr. Stanley C. Miller showed that basic materials for living matter could be made from hydrogen, methane and ammonia in a highly reducing atmosphere.

On the other hand, Dr. William W. Rubey of the U. S. Geological Survey has looked into the geological evidence of the origin of the atmosphere and oceans. He suggests that the water, carbon dioxide and nitrogen of our air and seas came out of volcanoes. He finds no evidence for the reducing atmosphere theory.

Dr. Abelson produced such amino acids as alanine, betaalanine, glycine, and sarcosine from mixtures of gases, such as carbon dioxide, nitrogen, hydrogen and water; carbon monoxide, nitrogen, hydrogen and water; carbon dioxide, ammonia, hydrogen and water. He confirmed the earlier work by Dr. Miller, now of Columbia University, obtaining amino acids from a mixture of methane, ammonia and water.

A thin, protective aluminum "skin" only one-fortieth as thick as the average skin on the human body, has been placed on copper wire to increase the life, reduce size and raise efficiency of present-day electrical equipment.

Most soil borne plant parasites grow more vigorously in soil freed of competing organisms by previous sterilization.

Papain, a plant enzyme obtained from the papaya, is the active ingredient in most commercial meat tenderizers.

New Analytical Methods Assure Greater Drug Safety

Better Quality Control for Drugs

➤ Pyramiding discoveries of potent new drugs have triggered the development of new analytical methods which assure greater safety for all drugs, says a report in *Analytical Chemistry*.

While making possible many of the spectacular recent advances in medicine, the ever-increasing output of new antibiotics and other highly complex pharmaceuticals has created problems of control undreamed of 50 years ago, explains Dr. W. B. Fortune who, as director of control for Eli Lilly & Company, Indianapolis, is responsible for the quality and purity of more than 1,100 compounds.

Conventional methods of analysis have been found inadequate to ensure the identity and purity of drugs in the rapidly changing chemical world of today. To meet the challenge of the new drugs, such modern instruments as spectrophotometers using ultraviolet and infrared as well as visual light have been put to work controlling the manufacturing processes. Radioactive tracer materials, X-rays, special separating columns, and gas analysis apparatus also are employed.

"We in the pharmaceutical field are faced with a constantly hanging Sword of Damocles with respect to the complete identity of the fine chemicals used in the pharmaceuticals produced," Dr. Fortune says. "A test which permitted the use of a relatively toxic raw material instead of a nontoxic one could produce side reactions and even death in patients using the pharmaceutical formulation. No pharmaceutical company could long exist if it makes such errors."

The first written directions governing the manufacture and control of drugs on a national basis in the United States was the original issue of the "Pharmacopeia of the United States of America," published in 1820. In 1906, Congress enacted the Pure Food and Drug Act. Thus the written national standards of the time acquired official status.

Now that classical methods of analysis are no longer adequate, pharmaceutical companies have established research groups whose specific responsibilities are to adapt new instrumentation and new and more precise methods of determining purity and identity to the constantly increasing array of drug products, says the report. Of his own company, Dr. Fortune states:

"Ten years ago our company had no designated chemists assigned to the specific job of developing new methods in the field of drug products, and to the assay of the fine chemicals from which they are made. Today, we have an analytical research group of 15 men working full time and sometimes overtime on the basic analytical research and developmental work necessary to transform a new method into a routine assay."

The old methods of analysis were

subject to errors in observation in many cases. Relying on a judgment of color, for example, the same test might give different answers from chemist to chemist and laboratory to laboratory. The newer methods, using precise electrical instruments, eliminate this source of error. In addition, the new methods have enabled chemists to find minute traces of impurities in drug products that could not be detected before.

"A quantity of gelatin used in preparing soft gelatin capsules for a multiple vitamin product was contaminated with an unusual amount of iron," the report says. "This unexpected contaminant was not picked up by the usual control testing of the gelatin. About 30 days after manufacture, the capsules appeared to have been thoroughly sprinkled with black pepper. The difficulty was traced to the reaction of vitamin C with the iron."

Dr. Fortune suggests that the requirements for drugs today include establishment of the identity of the product beyond question, freedom from products of similar composition as well as extraneous color or dirt, and absolute purity.

"When you have met these criteria using precise instruments and equipment and truly analytical methods," he says, "then, and only then, do you have a product worthy of being labeled under your company name as a fine chemical or pharmaceutical."

Fish Oil Kills Citrus Fungus

▶ A FISH OIL fungus-killer for citrus trees is being developed by Florida scientists.

Although fish oils have already been shown to be a good fungicide for citrus trees, Dr. Boris Sokoloff hopes to combine them with quaternary ammonium salts, a powerful bacteria-killer, to make a highly potent citrus spray.

Working under contract with the U.S. Fish and Wildlife Service at the Florida Southern College in Lakeland, Dr. Sokoloff is trying to combine the beneficial effects of the quaternary ammonium salts and fish oils into a single compound.

Extensive laboratory and orchard tests must be carried out before the full value of the fish oil products can be established. The best method of application also remains to be discovered. It is believed, however, that some type of spray will be most effective.

The quaternary ammonium salts were derived from unsaturated fatty acids of menhaden oil. A description of the chemical appears in the *Commercial Fisheries Review*.

Because it is relatively more resistant to high temperatures than is nylon, Dacron has been tested for use in parachutes for high-speed vehicles and missiles.

Less than one percent of the 35,000 species of fishes known in the world are now being utilized either as food or as oil, animal feed or fertilizer.

For The Home Lab

Oleic Acid from Olive Oil

by Burton L. Hawk

➤ For quite some time now we have been stressing the synthetic aspect of organic chemistry, with the resulting neglect on substances derived from natural sources. To remedy the situation, we will present from time to time descriptions of compounds extracted or prepared from natural occurring raw materials. Although synthetic chemistry has made enormous conquests, we are not yet one-hundred per cent synthesized and still must depend upon natural sources for many of our products.

The fatty acids are examples of a large group of compounds which are still obtained from natural sources.. (how long they will be we cannot tell!). Many people may not realize that the production of fatty acids is quite a large industry today and that these compounds go into the manufacture of many, diversified products which range from bombs and plastics to candles and shaving cream.

From the meat industry there is produced, among other things, a considerable quantity of animal fat. This product is "rendered" to obtain tallow. Tallow is an important commodity and is sold on the Produce Exchange Market. The price fluctuates daily and represents a sensitive barometer to world conditions. Domestically, tallow is used generally in two industries: the soap makers and the fatty acid producers. The fatty acid producers "split" the tallow by reacting it with acid and catalyst ("Twitchell" reagent), or with steam and pressure to obtain the free acids (stearic, linoleic, palmitic, oleic, etc.) plus glycerin. The glycerin is removed and the mixture of fatty acids separated into two products: red oil and stearic acid. This separation is accomplished by cooling and pressing or by solvent methods. The red oil of commerce is approximately 75-80% oleic acid. The stearic acid of commerce, strangely enough, contains less stearic acid than other fatty acids, such as palmitic.

We should like to demonstrate the preparation of oleic acid in the laboratory. But, as in many reactions, the commercial process is not very adaptable to the home laboratory. Also, animal tallow is not readily obtainable at the corner store. So we will use a slightly different method and will employ olive oil as our raw material. Olive oil is the glyceryl ester of oleic acid, palmitic, linolenic, and arachidic acids. By heating with alkali, we obtain alkali-salts of these acids (*via* the process of saponification); in this case, potassium oleate, palmitate, etc.

Dissolve 2½ grams of potassium hydroxide in 25 cc of good-quality denatured alcohol in a small wide-mouth flask. Add 8 cc of olive oil (U.S.P. grade from the Drug Store). The mixture should now be heated under a reflux for about 1½ hours. A straight piece of glass tubing will

serve as a reflux. Simply insert the tube in a one-hole stopper and the stopper in the flask. The tube should be of fairly large diameter (¼″ if you can fit it into the stopper) and should be from 18″ to 24″ in length. The object of this arrangement is to allow the mixture to boil steadily for a long period of time without loss of all liquid through evaporation. If you find that the liquid boils up and spills over the top of the tube, then you need a larger tube.

After heating for the specified time, remove from the flame and allow the mixture to cool partially. If you can still detect the odor of alcohol, heat the mixture gently in the open to remove the alcohol. The solution is now neutralized. Add a few drops of phenolphthalein. A red color should appear. Add dilute acetic acid, in small quantities, until the red color *just* disappears. This reaction converts the potassium salts to the free fatty acids.

Now we have a mixture of fatty acids. How to separate them? Well, we depend upon one property to effect this separation. For some unknown reason, lead oleate is soluble in ether; the lead salts of the other acids are not. Let us now convert the free acids to the lead salts. Dissolve 5 grams of lead acetate in 10 cc of water. Heating may be necessary. If the solution is turbid, filter and add to the fatty-acid mixture. There is precipitated a mixture of the lead salts of the fatty acids. Filter off the precipitate.

The extraction with ether must be handled very carefully. Remember, ether is extremely flammable and its vapors are explosive when mixed with air. Make certain that no open flames are in the vicinity and *never* heat ether with an open flame. Transfer the precipitate to a flask. Pour in a small quantity of ether. Stopper the flask and shake vigorously for a few seconds. Remove the stopper immediately to release the pressure. Repeat this process several times, adding more ether if necessary. You should end up with a thin turbid emulsion. Filter this solution. The filtrate should be a fairly pure solution of lead oleate in ether. Pour into an evaporating dish and set in a warm place and allow the ether to evaporate by itself. Remember, no direct heating and no open flames in the vicinity!

The lead oleate that remains is now converted back to oleic acid. Simply add dilute nitric acid and stir. Allow the mixture to stand. Oleic acid separates as an oil. You may remove the oil with a separatory funnel.

Pure oleic acid is a colorless liquid, but as explained above, the oleic acid ("red oil") of commerce is not pure and is usually a light reddish-orange or yellow liquid. Oleic acid which is practically colorless is known as "white oil" commercially. Red oil is used in lubricating oils, in driers for the paint industry, in the textile industry, in the plastics industry, for the manufacture of soaps, detergents and polishing compounds. All of these products, and many more, make use of oleic acid . . . a by-product of the meat industry! They seem a far cry from the cattle grazing on the prairie, yet how closely are they related!

Eradication of the Medfly in Palm Beach County, Florida, was accomplished primarily by means of airplane-applied poison-bait sprays.

No Damage to Teeth or Body
Most Recent Studies Show

Fluoridation Helps Permanent Teeth

➤ FLUORIDATION of public water supplies is giving more help in the fight on tooth decay than was at first expected. And there is more evidence that it does not cause any damage to teeth or the body generally. Studies showing both were reported at a meeting of the American Public Health Association, in Atlantic City, N. J.

The original thought was that fluoridation of water would help keep decay from the permanent teeth only of children born after fluoridation was started. But 16-year-old children of Grand Rapids, Mich., who were five years old when fluoridation was started there and whose teeth had been formed, benefitted from the fluoridation. Children with first permanent molars which had already erupted when the program was started have fewer and smaller cavities than children in nearby Muskegon, Mich., where fluoridation was started several years later.

Other studies showed that the body is able to throw off an excess amount of fluoride, thus guarding against accumulating too much of the chemical. The kidneys excrete the largest part of an extra dose rapidly within the first hour after the dose. And older persons, who suffer most from diseases of the gums and underlying bone, do not get any more of this kind of trouble when they drink fluoridinated water.

The studies were by the following scientists from the National Institute of Dental Health, Bethesda, Md.: Drs. F. A. Arnold Jr., I. Zipkin, A. L. Russell, R. L. Hayes, Nicholas C. Leone, N. W. Littleton and C. L. White.

Does Not Cause Arthritis

➤ DRINKING fluoridated water will not cause arthritis. A two-year study was made by Dr. Charles Leroy Steinberg, Rochester General Hospital, Rochester, N. Y., of the fluoride content of the bones and joints of arthritic patients who had been drinking fluoridated water for many years. Some of them were in their 70's and 80's. The amounts of fluorine found in those arthritics tested were normal.

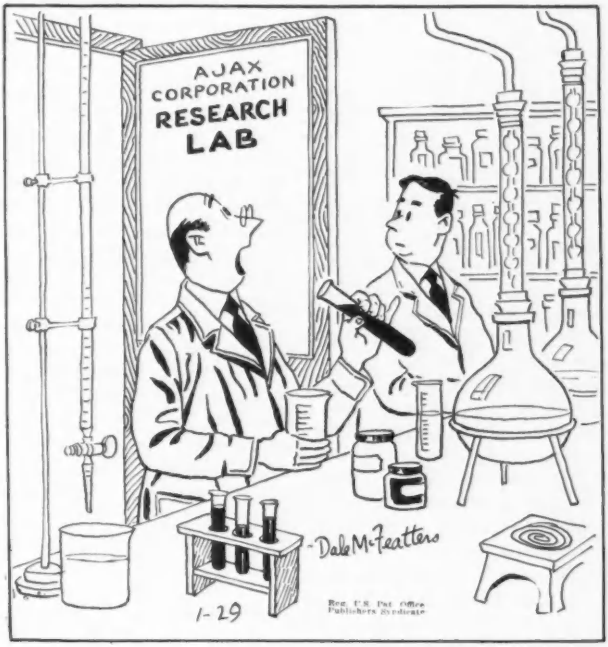
"Our study should dispel the fear that fluoridation of water as recommended by health authorities is a factor in the cause of arthritic conditions," Dr. Steinberg said.

There is enough evidence, he said, to confirm the fact that fluoridated drinking water will prevent tooth decay when the water contains one part per million of fluoride, and when the water is used by children from birth up to 12 years of age.

"Our studies were concerned with the possible ill effects that fluoridation may have on the adult and upon mankind in general, for it is known that in large quantities, in excess of five parts per million in drinking water, fluoride may have some detrimental effect upon bone and ligaments."

Dr. Steinberg and his team of researchers studied the tissues of the ribs, vertebrae, and joints of patients with arthritis. Normal amounts of fluoride were found in ribs and joints, he said, and slightly less than normal amounts were found in vertebrae.

The study, which was reported at a recent meeting of the American Rheumatism Association, was conducted at the University of Rochester School of Medicine and Dentistry, Rochester, N. Y. Joint authors of the report were Drs. Dwight E. Gardner, Frank A. Smith and Harold C. Hodge of the division of pharmacology and toxicology, University of Rochester School of Medicine and Dentistry.



➤ *"I'm on a deadline — got to come up with something they already have a terrific commercial for!"*

Big Engineering Problem of Peacetime Nuclear Technology

Disposal of Radioactive Wastes

by JOSEPH A. LIEBERMAN, *Sanitary Engineer, Engineering Development Branch, Division of Reactor Development, U. S. Atomic Energy Commission.*
(Remarks before the Engineering and Sanitation, Laboratory, and Occupational Health Sections of the American Public Health Association.)

➤ THE HANDLING and disposal of radioactive wastes is a general problem whose thread runs through the complete fabric of peaceful nuclear energy operations. In the peacetime day-to-day application of the benefits of nuclear energy, the disposal of wastes potentially represents the major "non-beneficial" effect on the public and its resources. Therefore, it is probably this segment of the operations that is of greatest direct interest to the public health professional. Waste materials in either gaseous, liquid or solid form are evolved in essentially all operations associated with nuclear energy facilities, beginning with mining of ore, through feed material production, reactor operation and chemical reprocessing of reactor fuels. Because of the nature and characteristics of the radioactivity involved, including, in specific instances, very long effective life, its ability to cause damage to human tissue; and its potential danger as an environmental contaminant, the safe handling and final disposal of wastes from the nuclear energy industry are integral and important aspects of these operations. This importance is attested to by the efforts expanded in the atomic energy program to date on this subject. More money probably has been spent, and more scientific and technological effort concentrated, on facilities, operations, and research and development with regard to this industrial waste than on any other industrial contaminant we have known.

It has been said a number of times that the widespread peaceful and beneficial application of nuclear technology will depend to a considerable degree on our ability to find practical solutions to problems of waste handling and disposal associated with nuclear operations. While it reasonably can be argued that no industry can be considered a mature segment of our economy unless and until it handles and disposes of its wastes in an acceptable manner, there is sufficient basis for the belief that the nuclear energy industry can develop in a rational way without being "bottlenecked" by its wastes. This conviction should not, however, carry the implication that specific answers are immediately available. Much research, development, pilot-plant testing and field evaluation have yet to be done before firm engineering conclusions will be possible for all situations.

No Single Best Solution

Early in this discussion it is important to emphasize that the disposal

of radioactive wastes, from an engineering and environmental standpoint particularly, cannot be considered as a single problem with a single, best solution. The great variation in the characteristics of the waste products from various processes and operations, including half-life, chemical state and concentration, physical nature, the actual quantities of materials involved, and the specific location of the nuclear facility are all important in assessing the significance of the hazard and in establishing engineering design criteria for their handling and disposal.

One of the major objectives of our engineering in this field is control over the radiation hazard from these wastes. Obviously, this involves control over the movement or mobility in the environment of the waste products themselves. This introduces the two basic waste disposal concepts that are applicable to the waste problem in its broadest sense. The radioactive materials may be permanently confined or isolated within restricted areas, away from people and their resources. This is the concept of "concentrate and contain". On the other hand, the radioactivity may be irreversibly reduced to safe levels by dilution in nature. This is the concept of "dilute and disperse". For example, with suitable environmental conditions, certain types of laboratory liquid wastes in which the concentration of radioactivity is only a few times greater than drinking water standards may be disposed of under the latter concept. At the other end of the spectrum, highly active liquid wastes originating from the chemical processing of irradiated fuels must be handled under the former philosophy. For all practical purposes, the waste materials evolving from the chemical processing of irradiated fuels contain, by far, the greatest concentrations and total quantities of radioactivity, and constitute the bulk of the long-term technological problem of waste disposal. It should be emphasized, however, that the fact that wastes containing smaller quantities of radioactivity may be amenable to direct dispersal in the environment makes it inherently important to carefully control such operations to assure that the safe capacity of the environment is not exceeded.

So much for background and philosophy. Now, what specifically, are these radioactive wastes we are concerned with? How do we handle them at the present time and what are some considerations for the future?

Cleaning the Air

Characteristics of gaseous and/or airborne particulate wastes vary widely depending on the nature of the operation from which they originate. In gaseous form they may range from rare gases, difficult to remove, such as Argon (A^{41}) from air-cooled reactors, to highly corrosive gases such as hydrogen fluoride (HF) from chemical and metallurgical processes. Particulate materials (aerosols) may be organic or inorganic and range in size from less than 0.05 microns to 20 microns. The smaller particles originate from metallurgical fumes caused by oxidation or vaporization. The larger particles may be acid mist droplets which are low in specific gravity and may remain suspended in air or gas streams for longer periods.

An outstanding feature of air cleaning requirements for many nuclear energy operations results from the extremely small permissible concentrations of various nuclides in the atmosphere. Often removal efficiencies of the order of 99.9% or greater for particles less than 1 micron in diameter are necessary. These criteria are much more stringent than heretofore encountered in industrial hygiene engineering, and in the early days of the industry, could not be met by general industrial dust control equipment that was then available. This situation was met by a research and development program that encompassed fundamental studies on the characteristics and behavior of aerosols, the design of specialized equipment and the evaluation of the dispersion of these materials into the atmosphere. As a result of this program such air cleaning units as high-efficiency filters capable routinely of removing 99.95% of particles 0.3 microns in diameter were developed and put into commercial production. A packed tower unit which utilized the chemical reaction between iodine and silver nitrate and capable of removing I^{131} from gas streams with efficiencies greater than 99.99% was designed and put into successful operation, and other special air cleaning devices were developed. The principles of atmospheric diffusion and dispersion were quantitatively evaluated to the point where these factors could be utilized in the overall design of gaseous waste treatment facilities. Also, fundamental information was, and is being, obtained on the characteristics of aerosols to serve as a sound basis for improved assessment of gaseous waste problems and continued development of improved air cleaning equipment.

Some aspects of future air cleaning problems which require further technical effort include high efficiency filtration at temperatures above 1000-1500°F, and, if very short time cooled fuels are processed, even more efficient removal of iodine. The question of the biological role of a discrete, individual radioactive particle is still under active consideration and its resolution might well influence the performance criteria of engineering facilities designed to control particulate effluents. Nevertheless, for the most part, handling and disposal of gaseous wastes from nuclear facilities is amenable to practical engineering control.

Radioactive Burial Grounds

Solid radioactive wastes such as non-usable contaminated equipment, non-recoverable scrap, and contaminated trash which are produced in all operations do not constitute a serious technical problem. However, if inadequate provisions are made for their proper handling and disposal they could be a distinct nuisance and, under certain circumstances, even a hazard. The levels of radioactivity associated with solid wastes may vary from a few times background to quantities requiring substantial shielding or remote handling. The engineering of systems for handling and disposal of solid wastes has been relatively simple. Burial of such wastes under known, controlled conditions and, in specific instances, disposal at sea have successfully and safely handled the problem.

Established burial grounds for solid radioactive wastes exist only at large atomic energy production and development sites such as Oak Ridge, Idaho, Savannah River, Hanford and Los Alamos. These facilities are in isolated areas with detailed geology and hydrology generally favorable to burial ground locations. Within AEC the operating establishments other than those noted above usually consist of relatively small areas and are in or near densely populated sections with perhaps less favorable geology and hydrology. In these cases the general procedure is not to dispose of wastes on site but to ship to one of the established burial grounds for final disposition.

In this latter connection we are confronted with the problem of locating another suitable burial ground (or grounds) to facilitate and reduce the cost of these operations. This situation is most pressing in the Northeastern United States where, at present, the only available disposal sites are Oak Ridge and the Atlantic Ocean. It is generally felt that solid waste disposal facilities should not be indiscriminately scattered around the country. (The proposed AEC regulations on standards for protection against radiation do permit "on-site" burial of very small quantities of radioactivity, however.) Accordingly, AEC staff is now engaged in investigations directed toward the possibility of establishing a solid waste handling and disposal facility to service the Northeastern U. S. How such a facility may be operated has not yet been decided, but insofar as technically and administratively feasible commercial participation will be encouraged.

To date relatively small quantities of radioactivity (estimated in the range of hundreds of curies, with the major contributions coming from Brookhaven National Laboratory, Bettis Field, and the University of California Radiation Laboratory) have been disposed of at sea. In these instances this has been a safe, practical method of disposal. However, among other things, the costs of sea disposal operations, including shipping to port, etc., appear to preclude the widespread use in this country of this method over burial.

Incineration of combustible, solid wastes to reduce volume and facilitate ultimate disposal has been practiced to a limited extent. The engineering and economic advantages of incineration over other approaches, including compressing, baling and direct burial have not been demonstrated but concentration by burning may be practical in specific circumstances. A special unit to burn 30 pounds per hour has been developed by the U. S. Bureau of Mines and is now being put into operation at the Harvard Air Cleaning Laboratory in connection with final development of a suitable air cleaning component. Where quantities of activity associated with solid wastes are low the use of a "solid dilution" approach, i.e., disposal into a municipal or institutional incinerator may be acceptable. This problem is now being considered in some detail by a special sub-committee of the National Committee on Radiation Protection of the U. S. Bureau of Standards. An NBS Handbook on this subject is the objective of this sub-committee.

Two Kinds of Liquid Wastes

Liquid radioactive wastes are evolved in all nuclear energy operations from laboratory research to full-scale production. As previously indicated, it is important to differentiate between what we call a "high-volume, low-level" waste, for example, the contaminated laundry waste which may contain say a few microcuries of radioactivity per gallon; and a low-volume, high-level" waste resulting from chemical processing of nuclear reactor fuels which may contain up to 1800 or more curies per gallon. Although both of these categories are radioactive wastes and both are liquid the similarity ends right there. The engineering problems of handling and disposing of these two categories are entirely different.

Liquid wastes with low concentrations of radioactivity originate in laboratory operations where relatively small quantities of radioactive materials are involved, ore and feed material processing, the normal operation of essentially all reactors, particularly watercooled types, and the routine operation of chemical processing plants. These low activity wastes, under proper environmental conditions, are susceptible to either direct disposal to nature or to disposal following minimum treatment. Treatment processes used include co-precipitation, ion-exchange, biological systems similar to sewage treatment methods and others. Because of their relatively high volume (on the order of millions of gallons per day) total costs for treatment may be substantial. Therefore, to the extent that it is absolutely safe, maximum use is made of dilution factors that may be available in the environment and that can be assessed quantitatively. This points up the importance of proper site-selection for nuclear energy facilities and the necessity for quantitative data concerning the environment.

Fuel Processing Wastes

High-activity liquid wastes associated with the chemical processing of reactor fuels, as already indicated, constitute the bulk of the engineering problem of disposal of radioactive wastes. It should be pointed out clearly that these wastes do not come directly from the reactors themselves, although under the improbable conditions of reactor malfunction some high-activity waste material may result. In the future such wastes also may be associated with certain types of homogeneous reactor sites to the extent that continuous fuel processing right at the reactor is envisaged. At the present time, however (and very likely for the immediate future), chemical processing plants are essentially the sole source of the wastes. Production-scale chemical plants are presently located at Savannah River, Hanford and Idaho.

Chemical processing of reactor fuels is done to separate and recover unfissioned or unburned fuel from the desired product and the wastes. At the present time, this means, for the most part, separating uranium, plutonium and fission products. The fission products which constitute the "hot" component of the wastes are radioactive elements ranging in mass number from 70 to 162. From an environmental standpoint, the more troublesome of these elements include strontium, cesium and others in the rare earth series. In the solid fuel

element prior to separation (which is today generally an aqueous chemical process), the concentration of fission products ranges from 100 to perhaps 1000 ppm. In the course of processing, the fission product concentration is considerably diluted by solvents, water and other solids. The resulting liquid wastes streams are, therefore, quite dilute as far as mass concentration of fission products is concerned. However, as previously stated, because of the high specific activity of these elements, these wastes may contain quantities of radioactivity up to several hundreds of curies per gallon. The effective life of this radioactivity may be measured in hundreds of years. These wastes also may generate heat to the extent of 10 to 50 Btu per gallon per hour.

10,000,000 Gallons Per Year

The quantity of high-level wastes generated depends largely on the chemical and metallurgical characteristics of the fuel being processed and the specific nature of the chemical process involved. It may range from 0.1 gallons to 5.0 gallons per gram of uranium processed. On a total volume basis, it is estimated that we have to consider waste production rates of the order of a tens of millions of gallons per year.

From the viewpoint of the sanitary engineer, it is perhaps misleading to apply the term "disposal" to current methods of handling highly radioactive liquid wastes. With only minor exceptions these wastes are not "disposed of" but are stored in specially designed tanks. Since the effective life of the fission products constituting the wastes may be measured in terms of hundreds of years, it is apparent that tank storage is not a permanent, long-term answer to the disposal problem. The latter point is accentuated by the fact that the capital cost of tank storage varies from about $0.30 to roughly $2.00 per gallon capacity.

Dispersal No Solution

What, then, are the possibilities for disposing of the high-level wastes? First, based on various estimates on the growth of nuclear energy in this country one can calculate the total cumulative quantity of radioactivity to be disposed of at given times in the future. Depending on whose nuclear energy growth estimates are used the radioactivity accumulations range from about 3×10^9 to 2×10^{10} curies in 1965 to about 4×10^{11} to 1×10^{12} in the year 2000. Now, when one considers the generally extremely low maximum permissible concentrations of radioactivity in air and water it becomes apparent that there is not enough dilution available in nature to enable any practical, continuing dispersal of these wastes into the environment. The application of the dilute and disperse philosophy does not appear to be a very good possibility.

A possible exception, but somewhat academic at the present time, is disposal at sea. Some oceanographers have indicated that based on general knowledge of the behavior of ocean deeps (12-15000-foot depths) and marine biology, it appears that substantial quantities of radioactivity may be disposed at these depths safely. They also indicate that much detailed oceanographic work is required before actual sea disposal criteria could

be established. This present lack of detailed oceanographic information coupled with the complete loss of control of the material once it is disposed, the complex engineering problems and high estimated costs involved in handling, transporting and actual placing of these wastes in the ocean deeps leads one to the conclusion that sea disposal is probably a secondary possibility at this time.

Possible Disposal Methods

Several practical approaches to ultimate safe disposal of high-level wastes appear possible. These possibilities are briefly described below. Work on these approaches is being carried out at a number of AEC installations.

1. *Fixation in inert media.*

The objective is to fix the radioactive waste material, i.e., the actual fission products, in an inert solid carrier so that the possibility of migration of the radioactivity into the environment is eliminated or reduced to acceptable and safe limits. The carrier containing the radioactive material could then be permanently stored or buried in selected locations without deleterious effect on man or his environment. Fixation on clay, incorporation in feldspars, conversion to oxide-elutriation of oxide-fixation of elutriant are examples of systems under development.

2. *Special separation of specific isotopes.*

Because of the particular radiotoxicity and long half life of Sr^{90} (25 years) and Cs^{137} (33 years) the removal and separate fixation and handling of these two isotopes would substantially reduce the effective life of the remaining material and facilitate its final disposal. With Cs and Sr removed, the possibilities of safe disposal into the environment under controlled conditions are greatly increased. The economic utilization of the Cs particularly, is an added incentive to such separations. Since Cs has fairly energetic beta and gamma emissions and a 33 year half-life it is a useful radiation source.

3. *Direct discharge to selected geologic formations.*

Preliminary evaluations indicate the possible technical feasibility or direct disposal of highly radioactive liquids into the ground following somewhat similar practices in other industries, but taking into account the unique characteristics of radioactive wastes. It may be practical to dispose of the wastes underground in some cases without any treatment, into such formations as:

a. Spaces prepared by dissolution in salt beds or salt domes.

b. Deep basins (5,000 to 15,000 feet in depth) containing connate brines and with no hydraulic or hydrologic connection to potable waters or other potentially valuable natural resources.

c. Special excavations in selected shale formations.

There are a number of engineering problems that must be solved before final engineering of a prototype installation utilizing the above schemes is possible. In the fixation schemes the requirement for equipment to withstand highly corrosive media, to control highly active aerosols which are evolved and which can be operated remotely with absolutely mini-

mum maintenance, is no small order. Progress along these lines is being made, however. In the separation of specific nuclides, the outstanding requirement is the high degree of separation required in order to handle the remaining material essentially as a low level waste. Decontamination factors of the order of 10^6 are necessary, i.e., 99.9999% removal of Cs and Sr. Here, too, progress is being made. In the direct disposal systems, questions relating to the physical and chemical reactions between the wastes and the formation material, control of thermal heat due to radioactive decay, and potential transport problems have to be answered. Work along these lines is now in its beginning stages.

One aspect of the over-all subject of waste disposal which deserves special note is that of site-selection for nuclear energy facilities. Detailed consideration of this subject would require a separate discussion.* However, it should be emphasized here that it is essential in any evaluation of, or attack on, the problem of wastes to integrate fully the varying conditions of site. This may seem like an obvious statement hardly requiring emphasis; nevertheless, it is surprising to observe the past instances in other industries in which such integration was not properly carried out and resulted either in increased costs or problems of environmental contamination. It is gratifying to note the positive attitude prevalent in industry today with regard to these problems. In planning for the expansion of the nuclear energy industry, special emphasis should be placed on this point of site selection. This important consideration accounts for our continuing, close, day-to-day working relationship with the meteorologist, geologist, hydrologist and associated disciplines.

Specific note must also be made of the administrative aspects of the operation of the nuclear energy industry, including control, regulations and public relations. The various disciplines in public health, through experience, are particularly cognizant of the importance of these considerations. They also recognize the very close tie-in between these factors and waste handling and disposal, and the vital necessity for a firm base of scientific and engineering information on which they can establish rational administrative criteria and procedures.

Changing technology is a characteristic of the nuclear energy business. New reactors, new fuel elements, new chemical processes, and new uses of radiation may have a profound effect on the nature of the waste problem and its solution. In the future, it will become perhaps even more important to maintain a close working relationship between the nuclear engineer, the chemical engineer, the sanitary engineer and the environmentalist. To my knowledge, no other industry has faced the challenge of the diverse problems in waste disposal that is in front of the nuclear energy industry. But we who are working on this fascinating and challenging problem look forward to the future of our industry with courage and confidence. In this scene, the public health profession has its part to play and its contribution to make.

* Gorman, A. E., "Significant Environmental Parameters in the Selection of Sites for Atomic Energy Plants." Annual Convention. American Society of Civil Engineers (October) 1956.

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Non-Corroding Zirconium

➤ ZIRCONIUM alloys having high resistance to corrosion and easily formed into the desired shapes were awarded a patent No. 2,772,964. Zirconium provides the best material for nuclear reactors. The metallic combinations consist of zirconium, from a tenth to two and a half percent by weight of tin and at least a tenth of a percent of a metal selected from the periodic table group containing iron, nickel, and chromium. Impurities amount to less than five-tenths of a percent.

Donald E. Thomas, Kenneth M. Goldman, Robert B. Gordon and William A. Johnson, Pittsburgh, Pa., devised the alloys, which have "a low corrosion rate at elevated temperatures when in the presence of water or steam." They assigned their rights to Westinghouse Electric Corporation, East Pittsburgh.

Zirconium is almost as strong as steel, but lighter. Since it does not absorb and thus waste the neutrons needed to sustain a chain reaction, it is used in building atomic reactors.

Identification Card

➤ A RADIOACTIVE identification card bearing a code number invisible to the human eye is the invention of Leonard I. Hall of Rochester, N.Y., which won him patent No. 2,773,196.

A central layer between two outside layers carries the radioactive material. It is ruled off in rows and columns to make small squares, certain of which are impregnated with radioactive material. The location of a particular radioactive square designates a specific number, and the number of the card is determined by the location of all the impregnated squares. Mr. Hall suggests that the two outside layers be made of material opaque to visible light, one having a number that can be seen, and that the visible and invisible numbers be different.

"Tinkertoy"

➤ THE "TINKERTOY" method for mass producing electronic devices uses ceramic wafers as building blocks. The automatic system uses an entirely new concept for making electronic equipment. However, it is simple enough to be practiced by hand or with the aid of only rudimentary tools.

Robert L. Henry Jr., Silver Spring, Md., received patent No. 2,771,663 for the method of making modular electronic assemblies. He says that quality of the equipment so produced, at a relatively low cost, equals or surpasses today's standards.

Electronic equipment used by the military alone is very diversified. The Tinkertoy process is easily adaptable

for mechanical production of various types of equipment.

Using it, a manufacturer can truck raw materials in one door of his factory and cart away finished radar circuits, for instance, through the other door. He can make all his own components, thus freeing himself from depending on another manufacturer for resistors, capacitors, etc.

Basic unit in the system is a ceramic wafer made of steatite, a ceramic that possesses satisfactory hardness, strength, heat dissipating ability and electronical insulating qualities.

After the wafer has been fired and notched, silver lines for carrying the electrical current are printed on it to form one small section of an electronic circuit. Then tape resistors or thin ceramic capacitors are bonded in place on the wafers.

A selected group of wafers is fed into a machine that solders them together with riser wires that join notches on the edges of the wafers. An amplifying stage for a radio or radar set is complete when a tube is plugged into the top wafer.

Mr. Henry assigned his patent rights to the United States of America as represented by the Secretary of the Navy, for use by the Government without royalty payments.

32 Patents To One Man

➤ In one day, Melvin De Groote of University City, Mo., either alone or jointly, was awarded 32 patents, setting a record few people equal in a year. His "highly unusual" Christmas present to the Petrolite Corporation of Wilmington, Del., is rights to patents Nos. 2,771,425—2,771,455 and No. 2,771,471. Of these, 19 were granted jointly with Kwan-Ting Shen of Brentwood, Mo., who was also awarded patent No. 2,771,462. One was granted jointly with Bernhard Keiser of Webster Groves, Mo., while patent No. 2,771,471 and 11 others were awarded to Mr. De Groote individually. All deal with chemical compounds or processes adapted for breaking up petroleum emulsions of the water-in-oil type. Sometimes called "cut oil," these consist of fine droplets of water or brine dispersed in oil to form an emulsion.

New Cobalt Dyes

➤ An entirely new class of cobalt compounds has been developed for dying textiles by two Germans.

The cobalt chemicals can also be used for printing textiles in color, the two inventors state. Fritz Baumann, Leverkusen-Bayerwerk, and Berthold Bienert, Leverkusen-Wiesdorf, Germany, call their discovery of the intermediates for phthalocyanine dyeing "surprising."

One advantage of using the cobalt compounds, they state, is that the cobalt phthalocyanines can be prepared directly on the fibers to be dyed, because the reactions proceed at lower temperatures than previously possible.

The new complex compounds contain one atom of cobalt for each six molecules of phthalonitrile. They are converted into cobalt-phthalocyanines by applying heat. The color ranges from yellow to a brown-red that changes to orange-red upon reaction with primary amines.

The chemicals are obtained by reacting a cobalt salt and urea, and such compounds as phthalic anhydride, in the presence of ammonium molybdate as a catalyst, at tempera-

tures of about 330 degrees Fahrenheit. The reaction is stopped when the yellow to brown-red solid is formed.

The Germans assigned their rights to patent No. 2,768,867 to Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany.

Spots Magnetic Targets

➤ AN AUTOMATIC bombing control system that detects and releases bombs or missiles from aircraft at magnetic targets has been granted a patent, 12 years after it was applied for.

The invention consists of two magnetometers, instruments sensitive to magnetic fields, mounted on the wing tips of airplanes or at either side of the gas bag of lighter-than-air craft. They are so connected that effects of the earth's magnetic field are eliminated, the missile or bomb being released automatically only after the device has determined the target is within range.

James H. Stein of Garden City, N. Y., applied for a patent on this bombing control method on July 4, 1944. He assigned rights on patent number 2,767,616 to the United States of America as represented by the Secretary of the Navy.

Mill Waste Refines Iron

➤ WASTE from the nation's paper mills may mean an additional source of iron ore for the nation's steel mills.

The process provides for the refining of low grade limonites or "brown ores," currently being ignored because there has been no practical and economical means for refining them. Now, however, Richmond E. Perry of Tuscaloosa, Ala., has come up with a reduction of these ores that can be used effectively to separate the low grade iron ore from its impurities.

To separate the iron-oxide minerals from the impurities such as sands, clays, cherts and other minerals, Mr. Perry uses tall oil, a waste or by-product from the pulp making industry.

The tall oil is used as an anion-active collecting agent. During the refining process, the iron ore is coated with a film of petroleum oil and tall oil. This aids it in floating while the impurities sink to the bottom of a flotation machine. The iron-oxide is then skimmed off the top of the bath.

Mr. Perry received patent No. 2,769,541 for his invention and assigned the patent rights to the United States Pipe and Foundry Company of Burlington, N.J.

Plutonium Separation

➤ A METHOD of separating plutonium from uranium using carbonate precipitation won patent No. 2,768,871 for three scientists, Dr. Harrison S. Brown and Dr. Orville F. Hill of Oak Ridge, Tenn., and Dr. Arthur H. Jaffey of Chicago, Ill. They assigned rights to the patent, which was applied for in 1945, to the United States of America as represented by the Atomic Energy Commission.

Ultrasonics For Paper Pulp

➤ USING ultrasonic waves for accurate process control of paper pulp stock and other materials is the development awarded patent No. 2,768,524. The amount of ultrasonic energy absorbed by the material varies with the distance through which the signal passed, Richard B. Beard of Philadelphia, Pa., states. He assigned his patent rights to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

Book Condensations

Chemical Process Economics in Practice — J. James Hur, Ed. — *Reinhold,* 115 p., illus., $3.95. Recording the fourth "Experience in Industry" symposium. Emphasis is on the practical aspects of the subject.

Encyclopedia of Chemical Reactions — Volume VI, Samarium, Scandium, Selenium, Silicon, Silver, Sodium — Compiled by C. A. Jacobson and edited by Clifford A. Hampel — *Reinhold,* 438 p., $12.50. A reference work for chemists.

Design in Civil Architecture: Elevational Treatments — Sir Albert Richardson and Hector O. Corfiato — *Philosophical Library,* 216 p., illus., $15.00. A selection of famous elevations with comments in English, French and Russian.

Nuclear Metallurgy: Vol. III — George H. Vineyard, Donald R. Thomas and Douglas S. Billington — *American Institute of Mining, Metallurgical and Petroleum Engineers,* IMD Special Report Series No. 3, 54 p., illus., paper, $3.75. Compilation of papers presented at a symposium on nuclear metallurgy in October, 1956.

Research Is People: A Discussion of the Recruitment, Motivation, Recognition, Rating and Evaluation of Research Personnel — J. H. Perrine and others — *Industrial Research Institute (New York University Press),* 69 p., illus., paper, $4.00. Discussion of the problems related to personnel engaged in research. Proceedings of a symposium held in April, 1956.

Perspectives in Organic Chemistry — Sir Alexander Todd, Ed. — *Interscience,* 527 p., illus., $7.50. A volume of essays covering a wide range of subjects gathered together to honor the 70th birthday of Sir Robert Robinson.

Chromium — Marvin J. Udy — *Reinhold,* American Chemical Society Monograph Series, Volume II of Metallurgy of Chromium and Its Alloys, 402 p., illus., $11.00. Discussing the recovery of chromium from its ores, the physical properties of this metal and its use as a refractory.

Thermodynamic Tables and Other Data — R. W. Haywood, Ed. — *Cambridge University Press,* 23 p., paper, 50 cents. Useful information for physicists and engineers.

Biological Sciences — J. C. Bugher, J. Coursaget and J. F. Loutit — *McGraw-Hill,* Series VI of Progress in Nuclear Energy, 205 p., illus., $7.00. Nuclear science has not only contributed new techniques and tools to the biologist, but it has also modified his patterns of thought.

Rheology: Theory and Application, Volume 1 — Frederick R. Eirich, Ed. — *Academic,* 761 p., illus., $20.00. Here authorities on the science of deformation and flow pool their knowledge and make it available in condensed form.

Modern Instruments in Chemical Analysis — Frank M. Biffen and William Seaman — *McGraw-Hill,* 333 p., illus., $7.50. To help the chemist to choose the instrument best fitted to his special needs.

Helen Miles Davis, 1895-1957

➤ Mrs. Helen Miles Davis, 61, chemist and editor of the magazine CHEMISTRY, died of cancer January 25, at Suburban Hospital, Bethesda, Md.

She was the wife of Watson Davis, director of Science Service, editor of the *Science News Letter,* and co-editor of CHEMISTRY. Other survivors are a daughter, Mrs. Calvin N. (Charlotte Davis) Mooers, and a son, Miles Davis, both of Cambridge, Mass.

Born in Washington, D. C., April 13, 1895, she was the daughter of the late Henry R. Miles and Charlotte Ketcham Miles. She had resided at 1422 Rhode Island Avenue, N. W., Washington, D. C., for 35 years. She spent her childhood in Harpers Ferry, W. Va.

Graduated from George Washington University College of Engineering with a B.S. in Chemistry degree in 1918, she was one of the first women on the scientific staff of the National Bureau of Standards, working in cellulose chemistry during the First World War. She engaged in the popularization of science, especially chemistry, and the history of science. Since 1944 she had edited CHEMISTRY magazine. She specialized in classics of science, compiling, interpreting and editing many great original announcements of scientific invention and discovery. These classics appeared in CHEMISTRY magazine and *Science News Letter*. She held a U. S. patent on a mold for concrete test specimens.

The following books were written or edited by her: *The Chemical Elements, Scientific Instruments You Can Make, Atomic Facts, Science Exhibits, Chemistry Show Book, Exhibit Techniques.* Her compilation of *New Laws of Matter* has run through five editions since its compilation just after announcement of the atomic bomb.

As chemistry writer for Science Service, she reported the Geneva (1955) conference on the peaceful uses of atomic energy, an atomic bomb test, and numerous meetings of the American Chemical Society and other scientific societies.

She was a member of the American Chemical Society, Chemical Society of Washington, the Congressional Press Gallery, Sigma Kappa sorority and the Eistophos Club.

➤ *Helen Miles Davis*